Brimleyana

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Brimleyana, the Journal of the North Carolina State Museum of Natural History, will appear at irregular intervals in consecutively numbered issues. Contents will emphasize zoology of the southeastern United States, especially North Carolina and adjacent areas. Geographic coverage will be limited to Alabama, Delaware, Florida, Georgia, Kentucky, Louisiana, Maryland, Mississippi, North Carolina, South Carolina, Tennessee, Virginia, and West Virginia.

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A Late Pleistocene Vertebrate Assemblage from Edisto Island, South Carolina

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ABSTRACT.—Edisto Island, South Carolina, was discovered as a vertebrate fossil locality during the early 1900s. Fossils collected by amateurs and professionals comprise an extensive, predominantly Late Pleistocene assemblage (approximately 10,000 to 120,000 years B. P.). The 37 genera present represent 9 orders of mammals and 3 orders of reptiles. Although the fossiliferous rock unit(s) from which the vertebrate material is derived remains unidentified, original deposition is considered to be alluvial and extensive regionally. The fauna gives evidence of a nearshore environment, including streams and marshes, and adjacent open savannah with scattered wooded areas. Several species, including the giant tortoise, *Geochelone,* indicate a probable frost-free climate. In additon, the occurence of *Palaeolama mirifica, Glyptotherium floridanum,* and *Geochelone* sp. at Edisto, extends the known geographic range of these species 322 kilometers (200 miles) northward.

INTRODUCTION

Terrestrial Pleistocene biostratigraphic zones are most clearly defined in western North America, and the mammal ages that serve as subdivisions within the Pleistocene are based on faunas from classic western localities (Fig. 1). In addition, the geologic ranges of many Pleistocene vertebrate species have been determined predominantly on the basis of their western occurrences (Hibbard 1958).

In contrast to the relatively clear picture of western North America, Pleistocene vertebrate paleontology in the southeastern United States is less well defined, and correlation with western localities has proved difficult (Hay 1923; Simpson 1929a; Hibbard 1958). However, Webb (1974) argued that the western mammal ages can be extended to include Florida. In all probability, the same applies to the rest of the Southeast.

Recently, interest in the Pleistocene vertebrates of the Southeast has increased, and several important contributions have been made. These include Webb's (1974) summary of the Florida Pleistocene, a substantial

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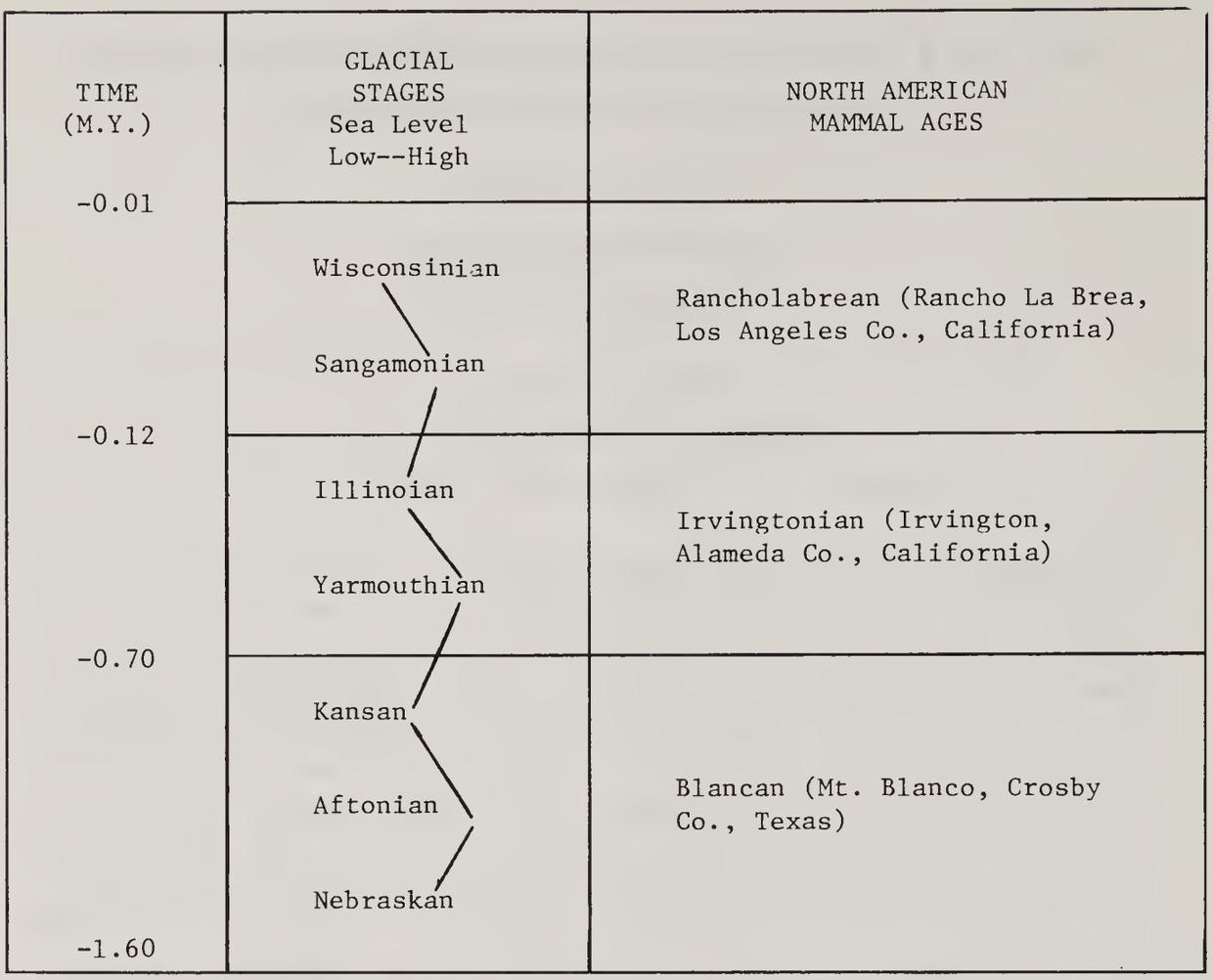

Fig. 1. Pleistocene glacial stages and North American mammal ages. Sea levels from Webb (1974). Absolute dates from Berggren and Van Couvering (1974).

Pleistocene fauna from Ladds Quarry, Bartow County, Georgia (Lipps and Ray 1967), and Pleistocene vertebrates in the Georgia piedmont (Voorhies 1974) and coastal regions (Frey et al. 1975). However, many areas of the Southeast have not yet been investigated, and distribution of certain species has not yet been adequately documented.

Vertebrate fossils at Edisto Island, South Carolina, were first reviewed by Hay (1923). Subsequently, Auffenberg (1957), Ray, (1965, 1967), Ray et al. (1968), Kurtén (1973), and Dobie and Jackson (1979) discussed individual species from Edisto. For closely comparable faunas in the Charleston and Ashley River areas see Hay (1923) , Allen (1926), and Hibbard et al. (1965). O'Kelley (1976) presented a preliminary faunal list from Edisto, based primarily on Holocene material. However, no comprehensive study of the Edisto fossil vertebrates has been attempted. The abundance of fossil material from the island coupled with its coastal geographic locale north of previously reported localities provides new information on paleoclimatic conditions of the Edisto area and the geographic range of particular species.

The purposes of this study are to: (1) report a rather extensive (36 species of reptiles and mammals), predominantly late Pleistocene fauna from Edisto Island, South Carolina; (2) consider the paleoecological and

paleoclimatic implications of the fauna; and (3) discuss the significance of the fauna in relation to other southeastern Pleistocene localities.

GEOGRAPHIC AND GEOLOGICAL SETTING

Edisto Island is a barrier island located 34 kilometers (21 miles) southwest of Charleston, South Carolina, at longitude 80°17'W and latitude 30°31'N (Fig. 2). Fossils are found in the intertidal zone along the beaches, along stream banks and estuaries, and occasionally are entrapped in fishing nets. The fossil material is typically well mineralized and black in color.

The fossils have not yet been found *in situ* and the fossiliferous stratum (or strata) has not been identified. There are, however, several possible source areas: (1) Holocene sediments on or near the beach, (2) the Silver Bluff formation of latest Pleistocene age which, according to Colquhoun (1969), lies immediately inland of the Holocene sediments, or (3) earlier Pleistocene strata which underlie the previously mentioned units and crop out offshore below sea level or in estuaries and streams. The fossils may be derived from any one or all of these units.

Although often reported from Jeremy Inlet and Edingville Beach, the fossils are found also at Botany Bay Island, Edisto Beach, and the southern tip of the island (Fig. 2). This widespread occurrence suggests that the depositional area was equally broad or that, once eroded, fossils are easily transported by currents to the widely separated points of discovery.

The large number of terrestrial species present in the Edisto Island fauna and the probability of an offshore source area suggest that sea level at the time of deposition was lower than the present level. Sea level fluctuated during the Pleistocene and Holocene, in response to alternating glacial and interglacial stages (Cazeau et al. 1964; Hoyt 1967; Whitmore et al. 1967; Winkler and Howard 1977). Webb (1974) related these fluctuations of sea level to the North America mammal ages and glacial stages within the Pleistocene (Fig. 1).

With substantially lowered sea level during Pleistocene glacial stages, what is now Edisto Island would have been a nearshore but inland area possibly exhibiting a savannahlike terrain; the deposition on Edisto Island was probably alluvial. Numerous Pleistocene streams and estuaries might have cut into underlying Pliocene and/or Miocene strata, deposited the Pleistocene vertebrate fossils, and possibly caused some mixing. Although evidence is not conclusive, the widespread recovery of fossil vertebrates along the southern Atlantic coast (Frey et al. 1975) suggests that the fossiliferous unit or units is extensive regionally. At Edisto Island, this unit probably crops out both in streams and estuaries on the island and in nearby offshore areas.

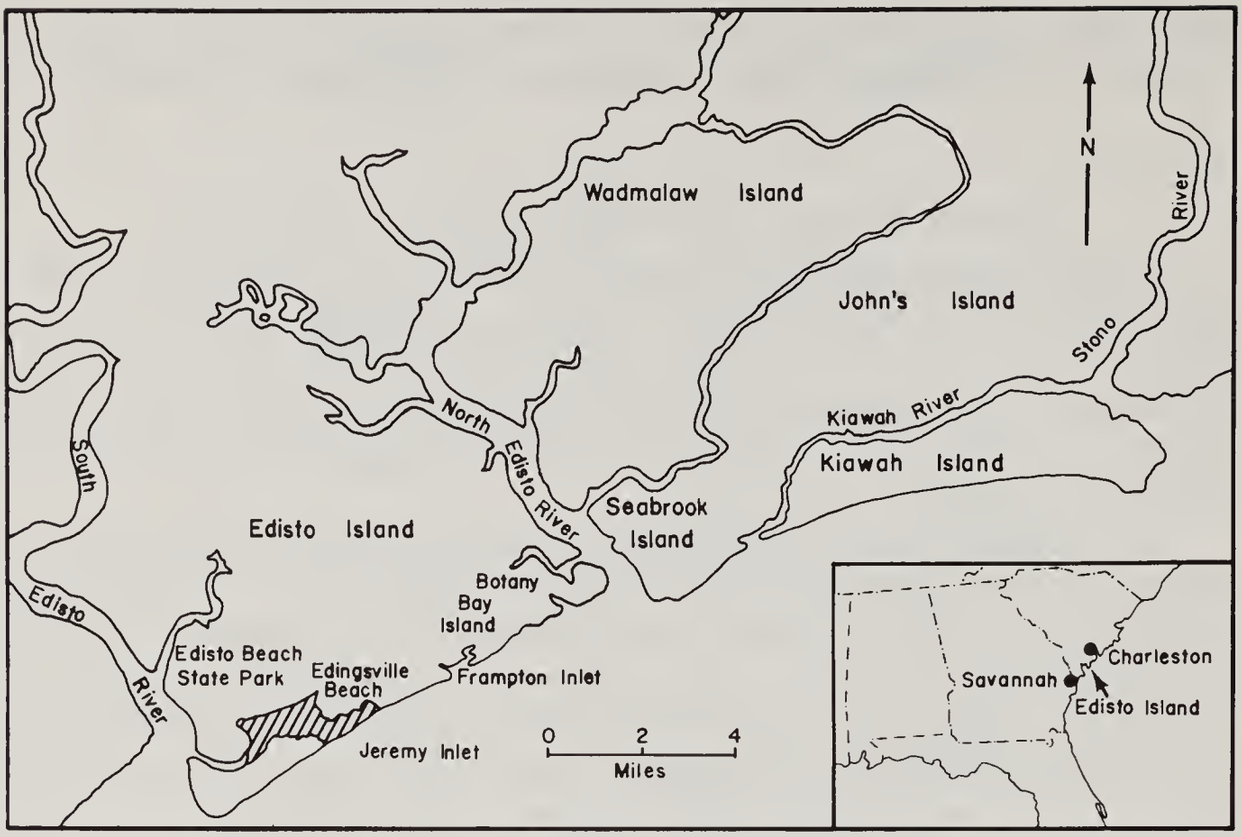

Fig. 2. Map of Edisto Island, South Carolina, and adjacent coastal area. Insert, map of eastern United States indicating location of Edisto Island.

MATERIALS AND METHODS

In addition to examining and identifying previously collected museum materials from Edisto Island, fossils were collected on the island from June to August, 1978. Collecting was carried out by general surface survey of beach and stream banks and by screening of beach sand through 1/16-inch wire mesh.

Museum abbreviations are as follows:

ChM, Charleston Museum
USNM, National Museum of Natural History, Smithsonian Institution
HS, Hampden-Sydney College collections
UGV, University of Georgia vertebrate fossil collections

FAUNAL LIST

The following faunal list includes all known mammalian and reptilian taxa from Edisto Island. Other fossil vertebrates are not included in this report.

Class Reptilia
Order Chelonia
Family Chelydridae
Chelydra serpentina

Family Kinosternidae
Kinosternon sp.
Family Emydidae
Chrysemys scripta cf. *petrolei*
Chrysemys floridana
Terrapene carolina putnami
Family Testudinidae
Geochelone sp.
Gopherus sp.
Family Trionychidae
Trionyx sp.
Order Squamata
Suborder Serpentes
Family Colubridae
cf. *Coluber* sp., or *Masticophis* sp.
cf. *Elaphe* sp.
Order Crocodilia
Family Crocodylidae
Alligator mississippiensis
cf. *Gavialosuchus* sp.

Class Mammalia
Order Edentata
Family Dasypodidae
Dasypus bellus
Holmesina septentrionalis
Family Glyptodontidae
Glyptotherium floridanum
Familty Megalonychidae
Megalonyx cf. *jeffersonii*
Family Megatheriidae
Eremotherium cf. *mirabile*
Family Mylodontidae
Glossotherium (Paramylodon) cf. *harlani*
Order Lagomorpha
Family Leporidae
Sylvilagus sp.
Order Rodentia
Family Castoridae
Castoroides cf. *ohioensis*
Castor canadensis
Family Hydrochoeridae
Neochoerus pinckneyi

Order Cetacea
- Family Delphinidae
  - *Tursiops* cf. *truncatus*
- Family Physeteridae
  - *Physeter* sp.
- Family Balaenopteridae

Order Carnivora
- Family Canidae
  - *Canis dirus*
  - *Urocyon* cf. *cinereoargenteus*
- Family Procyonidae
  - *Procyon lotor*
- Family Ursidae
  - *Tremarctos floridanus*
- Family Odobenidae
  - cf. *Odobenus rosmarus*
- Family Phocidae
  - cf. *Halichoerus grypus*
- Family Felidae
  - *Felis onca augusta*

Order Proboscidea
- Family Elephantidae
  - *Mammuthus* cf. *columbi*
- Family Mammutidae
  - *Mammut americanum*

Order Sirenia
- Family Trichechidae
  - *Trichechus* sp.

Order Perissodactyla
- Family Equidae
  - *Equus* sp.
- Family Tapiridae
  - *Tapirus* sp.

Order Artiodactyla
- Family Tayassuidae
  - *Mylohyus* cf. *fossilis*
- Family Camelidae
  - *Palaeolama* cf. *mirifica*
- Family Cervidae
  - *Odocoileus virginianus*
- Family Bovidae
  - *Bison* cf. *antiquus*

SYSTEMATIC PALEONTOLOGY

Many of the species discussed below occurred widely in North America during the Late Pleistocene. A complete listing of their occurrences and distributions is beyond the scope of this paper. We will, in general, limit our comments to known distributional records in the Southeast.

Descriptions of the geological ranges and comments regarding habitat preferences for the following species are provided in Table 1.

Class Reptilia
Order Chelonia
Family Chelydridae

Chelydra serpentina (Linnaeus) — snapping turtle

Material.—ChM.GPV1528, ChM.GPV1530-1531, ChM.GPV1533-1536, seven peripheral scutes; ChM.GPV1529, ChM.GPV1532, two costal scutes.

Family Kinosternidae

Kinosternon (Spix) sp. indet. — mud turtles

Material.—ChM.GPV1554, pygal bone.

Family Emydidae

Chrysemys scripta cf. *petrolei* (Leidy) — pond slider

Material.—ChM.GPV2093, carapacial fragment.

Remarks.—*Chrysemys scripta petrolei* is distinguished from Recent *C. scripta* by more rugose surficial sculpturing of the carapace and by its larger size (Weaver 1967).

Chrysemys floridana (LeConte) — Florida cooter

Material.—ChM.GPV622-623, two carapacial fragments.

Chrysemys floridana or *Chrysemys concinna* (LeConte) — cooters

Material.—ChM.GPV1461-1463, ChM.GPV1465-1470, nine carapacial fragments.

Remarks.—Both species range from the Pliocene to the Holocene and now occur in aquatic habitats in eastern coastal states. Additional *Chrysemys* material from Edisto Island has recently been reported elsewhere (Dobie and Jackson 1979) and is not considered here.

Terrapene carolina putnami (Hay) — giant box turtle

Material.—ChM.GPV2094-2095, two carapacial fragments.

Remarks.—*Terrapene carolina putnami* is distinguished from living *T. c. carolina* on the basis of greater size and increased curvature of the peripheral scutes. Fossil localities occur from Florida to New Mexico and at least as far north as Kansas.

Table 1. Geologic ranges and habitat preferences for species occurring in Edisto Island fauna.

SPECIES	GEOLOGIC RANGE
Chelydra serpentina	Hemphillian to Holocene (Holman 1966)
Kinosternon	Pliocene to Holocene (Holman 1972)
Chrysemys scripta petrolei	Rancholabrean (Weaver 1967)
Chrysemys floridana	Pliocene to Holocene
Chrysemys concinna	Pliocene to Holocene
Terrapene carolina putnami	Middle Pliocene to late Wisconsinian (Milstead 1969)
Geochelone sp.	Late Eocene to Holocene (Hibbard and Taylor 1960)
Gopherus sp.	Miocene to Holocene (Romer 1966)
Coluber sp. or *Masticophis* sp.	Pleistocene to Holocene (Holman, pers. comm.)
Elaphe sp.	Miocene to Holocene (Romer 1966)
Alligator mississippiensis	Oligocene to Holocene (Romer 1966)
Gavialosuchus sp.	Miocene to Pleistocene (Auffenberg 1954, 1957; Tadao 1969)
Dasypus bellus	Blancan to Wisconsinian (Robertson 1976; Ray 1967)
Holmesina septentrionalis	Irvingtonian to Rancholabrean (Webb 1974)
Glyptotherium floridanum	Rancholabrean (Gillette and Ray, in press)
Megalonyx jeffersonii	Blancan to Holocene (Hibbard et al. 1965)
Eremotherium mirabile	Rancholabrean (Hibbard et al. 1965)
Glossotherium harlani	Pleistocene (Stock 1925; Schultz 1965)
Syvilagus sp.	Kansan to Holocene (Hibbard et al. 1965)
Castoroides ohioensis	Late Kansan to late Wisconsinian (Semken 1966)
Castor canadensis	Illinoian to Holocene (Semken 1966)
Neochoerus pinckneyi	Wisconsinian (Lance 1958)
Tursiops truncatus	Pliocene to Holocene (Romer 1966)
Physeter	Miocene to Holocene (Romer 1966)
Canis dirus	Sangamonian to late Wisconsinian (Hibbard and Taylor 1960)
Urocyon cinereoargenteus	Rancholbrean to Holocene (Stevens 1965)
Felis onca augusta	Aftonian to late Wisconsinian (Ray 1967; Kurtén 1973)
Procyon lotor	Pleistocene to Holocene (Arta and Hutchison 1964)
Tremarctos floridanus	Illinoian to Holocene (Kurtén 1966)
Odobenus rosmarus	Nebraskan to Holocene (Ray et al. 1968)
Halich9erus grypus	Pleistocene (Ray et al. 1968)
Mammuthus columbi	Yarmouthian to late Wisconsinian (Miller 1971; Webb 1974)
Mammut americanum	Throughout Pleistocene (Miller 1971)
Trichechus	Pliocene to Holocene (Romer 1966)
Equus	Irvingtonian to Holocene (Martin and Webb 1974)
Tapirus	Blancan to Holocene (Hibbard et al. 1965)
Bison antiquus	Late Sangamonian to late Wisconsinian (Robertson 1974)
Palaeolama mirifica	Irvingtonian to Rancholabrean (Lundeluis 1972; Webb 1974)
Odocoileus virginianus	Late Irvingtonian to Holocene (Martin and Webb 1974)
Mylohyus fossilis	Blancan to late Wisconsinian (Semken and Griggs 1965)

HABITAT PREFERENCE

Any permanent body of fresh water (Conant 1975)
Muddy bottom aquatic habitats (Conant 1975)
Probable habitat in or near stream (Holman 1972)
Coastal plain ponds, lakes, swamps, marshes, and rivers (Conant 1975)
Predominantly streams but also coastal marshes (Conant 1975)
Coastal savannah subspecies (Auffenberg 1967; Martin 1974)
Tropical to humid subtropical habitats (Hibbard 1960; Loveridge and Williams 1957)
Predominantly dry sandy soils (Conant 1975)
Open woods or grassland usually near permanent water (Conant 1975)
Terrestrial and arboreal usually near reliable water sources (Holman 1972)
Tropical to subtropical aquatic habitats (Woodburne 1958; Conant 1975)
Tropical to subtropical aquatic habitats (Auffenberg 1954, 1957)
Variety of subtropical habitats (Slaughter 1959)
Variety of subtropical habitats (Gillette, pers. comm.)
Tropical to subtropical climate, lush vegetation, standing water (Gillette and Ray, in press)
Warm, dense, moist forest (Stock 1925)
Warm, dense, moist forest (Edmund, pers. comm.)
Open grasslands (Stock 1925)
Wide variety of forested habitats (Blair 1968)
Marshes, bogs, lakes, and rivers (Cahn 1932)
Marshes, bogs, lakes, and rivers (Blair 1968)
Moist temperature climate across southern North America (Hay 1927; Simpson 1930)
Atlantic Ocean, Massachusetts south to South America (Hall and Kelson 1959)
Arctic to tropical waters of Atlantic (Hall and Kelson 1959)
Presumably similar to modern *Canis*
Variety of woodland habitats (Blair 1968)
Densely wooded areas, frequenting streams (Kurtén 1973)
Forested areas, frequenting streams and marshes (Hall and Kelson 1959)
Variety of wooded habitats (Kurtén 1966)
Atlantic coastal area (Hall and Kelson 1959)
North Atlantic coastal areas, migrating into inlets and estuaries (Hall and Kelson 1959)
Open grasslands and savannah, with permanent water (Hibbard 1955)
Coniferous forests, probably boreal (Martin and Guilday 1967; Dremanis 1968; Voorhies 1974)
Atlantic coastal regions, frequenting bays and inlets (Hall and Kelson 1959)
Open grasslands, presumably similar to modern *Equus*
Predominantly humid tropical to subtropical forests (Simpson 1945; Gray and Cramer 1961)
Open grasslands, presumably similar to modern *Bison*
Grasslands and savannahs (Webb, pers. comm.)
Woodlands and forest edges
Warm moist woodlands (Martin and Guilday 1967)

Family Testudinidae

Geochelone sp. (Fitzinger) — giant land tortoise

Material.—ChM.PV2475, ChM.PV2486-2487, three carapacial fragments; ChM.GPV2005, ChM.PV2467-2476, ChM.PV2476, ChM.PV2478, ChM.PV2479-2485, ChM.PV2488-2492, twenty-one plastral fragments; ChM.PV2457-2462, ChM.PV2464, ChM.PV2466, eight peripheral scutes; ChM.PV2463, ChM.PV2477, two nuchal sctues; ChM.PV2465, costal scute; ChM.PV2497, osteoderm.

Remarks.—*Geochelone* is restricted to primarily subtropical and tropical climates (Hibbard and Taylor 1960). Previous reports of *Geochelone* include localities in Florida and several midwestern states (Hibbard 1960).

Gopherus sp. (Rafinesque) — gopher tortoise

Material.—ChM.GPV1537, carapacial fragment.

Order Squamata

Suborder Serpentes

Family Colubridae

cf. *Coluber* sp. Linnaeus or *Masticophis* sp. (Baird and Girard) — racers or whipsnakes

Material.—ChM.GPV2088, vertebral fragment.

Remarks.—The specimen is missing important processes, which precludes generic identification.

cf. *Elaphe* sp. (Fitzinger) — rat snake

Material.—ChM.PV2746, vertebral fragment.

Remarks.—The specimen is severely worn, making determination of species impossible.

Order Crocodilia

Family Crocodylidae

Alligator mississippiensis (Daudlin) — alligator

Material.—ChM.PV2493, right mandible; ChM.PV2494, right mandibular fragments; ChM.PV2501, mandibular fragment; ChM.PV2020, tooth fragment; ChM.PV2502, right dermal roof fragment; ChM.PV2503, left dermal roof fragment; ChM.PV2505, dermal roof fragment; ChM.PV2735, worn vertebral centrum; ChM.PV2496, ChM.PV2500, ChM.PV2752, three dermal scutes; UGV132a-c, dermal scutes; UGV136, skull fragment; UGV142, vertebra.

Remarks.—All specimens are very dark and well mineralized. The dermal scutes exhibit the diagnostic keel.

cf. *Gavialosuchus* (Toula and Kail) — giant crocodile

Material.—ChM.PV2495, right humerus; ChM.PV2504, right humerus; ChM.35.208.176, dorsal plate.

Remarks.—The two humeri are large, elongate, and do not compare well with available material of *Alligator* or *Crocodylus acutus.* The specimens are referred to *Gavialosuchus;* however, the limited knowledge of *Gavialosuchus* postcranial material prevents conclusive determination.

Gavialosuchus has been reported from the late Miocene to early Pliocene of Florida (Sellards 1915; Mook 1921; Auffenberg 1954, 1957). Auffenberg (1957) also noted two occurrences of *Gavialosuchus* from South Carolina: a partial skull (ChM.13745) from near Lambs, Charleston County, and one dorsal plate (ChM.35.208.176) from Edisto Beach. He suggested that the Edisto Island specimen is probably of Miocene age. The two specimens reported here may also represent Miocene or Pliocene components of a predominantly Pleistocene assemblage; or, it is possible the genus had a more extensive geologic range than has previously been reported. In the light of present knowledge of the geology of the region between Edisto Island and Charleston, a Miocene age for these specimens seems unlikely. Richards et al. (1971) reported Late Pleistocene mollusks from depths of 40 to 50 feet below the surface on Wadmalaw Island, John's Island, and James Island and concluded that they were of Sangamonian age. The Sangamonian deposits unconformably overlie the Oligocene member of the Cooper Formation. Offshore they are overlain by sediments deposited during regression in Wisconsinian time. Thus, there is no immediate source for fossils of Miocene age in the vicinity of Edisto Island. Reworked Miocene fossils may well occur at the base of the Pleistocene in this area as they do at certain places farther inland, but it is difficult to see how such material could be reworked upward through more than 50 feet of sediment. A gavialosuchid recorded from the Pleistocene of Japan (Tadao 1969) lends some credence to the possiblity that the Edisto specimen is Pleistocene in age.

Class Mammalia
Order Edentata
Family Dasypodidae

Dasypus bellus (Simpson) — beautiful armadillo

Material.—ChM.PV2705, dermal scute.

Remarks.—*Dasypus bellus* has been reported from as far west as Texas (Slaughter 1959) and north to Missouri, Tennessee and West Virginia (Guilday and McCrady 1966; Guilday et al. 1978). Localities include Ladds Quarry in northwest Georgia (Ray 1967). The earliest report of *D. bellus* is from the Blancan of Florida (Robertson 1976), but the species does not appear in the fossil record elsewhere until the Wisconsinian. See Table 2 for measurements.

Table 2. Comparative measurements (mm) of *Dasypus bellus* dermal scutes from Edisto Island and elsewhere.

	Thickness	Width	N
ChM.PV2705, Edisto Island	4.9	13.0	1
ChM.PV2092, Edisto Island	5.0	12.0	1
D. novemcinctus, Recent (Martin 1974)	0.9 — 2.4	3.5 — 8.1	235
D. bellus, Florida (Martin 1974)	1.9 — 6.1	6.2 — 16.5	194

cf. *Holmesina (Chylamytherium) septentrionalis* (Leidy) — giant armadillo

Material.—ChM.GPV2032, ChM.PV2785-86, ChM.PV2416, ChM.PV2619-2620, carapacial scutes; ChM.PV2420 caudal ring scute.

Remarks.—Chlamytheres apparently reached Flordia earlier than elsewhere in the U. S. (Webb 1974) and are known from several localities there (Robertson 1976). The Charleston specimens are referred to *H. septentrionalis,* known from Irvingtonian and Rancholabrean deposits (Webb 1974). The group is presently under review by Dr. G. Edmund.

Family Glypotodontidae

Glyptotherium floridanum (Simpson) — North America glyptodont

Material.—ChM.PV2415, cranial fragment; ChM.GPV2090, ChM.PV2417-2418, carapacial scutes.

Remarks.—The cranial fragment was described by Ray (1965) and identified as *Boreostracon floridanus* (Simpson), but Gillette and Ray (in press) refer all glyptodont material from Edisto Island to *G. floridanum.* This species is confined to the Rancholabrean. Geographically, *G. floridanum* is restricted to the Gulf coastal plain and the southern Atlantic coast, and the South Carolina specimen provides the northernmost record of the species.

Family Megalonychidae

Magalonyx cf. *M. jeffersonii* (Desmarest) — Jefferson's ground sloth

Material.—ChM.PV2421, right lateral mandibular fragment, dentition not preserved; ChM.PV2423, caninform tooth; ChM.PV2743, caniniform tooth; ChM.PV2455 and ChM.GPV2012, two molariform teeth; ChM.PV2424, ungual phalanx; ChM.PV2428, cast of ungual phalanx; HS.A-48, HS.A-29, HS.A-51, three caniniform teeth; HS.E-61, astragalus; from the private collection of M. W. Wagner, two ungual phalanges; UGV150, RM^1.

Remarks.—Ray et al. (1967) noted that the number of species of *Megalonyx* and their validity are uncertain. The Edisto Island specimens compare closely with material presently identified as *M. jeffersonii.* The geographic distribution of *Megalonyx* seems to have been widespread

over North America, and in the Southeast includes previously reported occurrences in South Carolina (Hay 1923), Georgia (Ray 1967), Florida (Webb 1974) and Tennessee (Guilday et al. 1969).

Family Megatheriidae

Eremotherium cf. *E. mirabile* (Leidy) — giant ground sloth

Material.—ChM.PV2426, ungual phalanx; ChM.PV2454, molar fragment; ChM.PV2400, lumbar vertebral fragment.

Remarks.—*Eremotherium* ranged from southern South America to New Jersey (but see Ray 1979) and has been reported from South Carolina and Georgia (A. Sanders, pers. comm.; Frey et al. 1975), and Florida west to Texas (Webb 1974; Lundelius 1972).

Family Mylodontidae

Glossotherium (Paramylodon) cf *P. harlani* (Owen) — Harlan's ground sloth

Material.—ChM.PV2422, third lower molariform tooth; ChM.PV2427, molariform fragment; ChM.PV2741, distal fragment of humerus; ChM.PV2429, ungual phalanx; ChM.GPV2004, metapodial; USNM22842, ungual phalanx.

Remarks.—The large ground sloth, *Glossotherium,* is known from the Pleistocene of North America. Its geographic distribution ranges from Central America to the Pacific and Atlantic coasts of the United States (Schultz 1965).

Order Edentata, gen. et sp. indet.

Two specimens, ChM.PV2739 and ChM.PV2740, both basal fragments of the neural spine, are comparable to ground sloth material but are otherwise indeterminate.

Order Lagomorpha

Family Leporidae

Sylvilagus sp. (Gray) — rabbit

Material.—ChM.PV2441, right mandible with P_3, M_1, and M_2; ChM.PV2442, molar fragment; ChM.PV2498, molar fragment; ChM.PV2738, portion of right tibia.

Remarks.—*Sylvilagus* is a relatively common and widespread constituent of North American fossil faunas beginning in the Late Pleistocene (Schultz 1965). Although the genus is an expected member of a Pleistocene fauna, the possibility that the specimens at Edisto Island represent a more recent occurrence of *Sylvilagus* on the island must be considered. Due to the apparent transport at Edisto Island the presence of *Sylvilagus* and other small mammals is a rare occurrence.

Order Rodentia

Family Castoridae

Castoroides cf. *C. ohioensis* (Foster) — giant beaver

Material.—ChM.PV2437-2438, two incisor fragments.

Castoroides ohioensis localities occur throughout the eastern two thirds of North America, and are concentrated in the area south of the Great Lakes (Dallman 1969). The species has also been reported in the Southeast, including Georgia, South Carolina (Hay 1923), Tennessee (Parmalee et al. 1976) and Florida (Martin 1969).

Castor canadensis (Kuhl) — beaver

Material.—HS.104, right femur.

Remarks.—Although the species is a common constituent of fossil faunas, this specimen may be modern.

Family Hydrochoeridae

Neochoerus pinckneyi (Hay) — giant capybara

Material.—ChM.PV2439, RM^3; ChM.PV2440, RI^1.

Remarks.—This giant capybara was described by Hay (1923) as *Hydrodchoerus pinckneyi* on the basis of a left upper third molar from the Charleston area with which ChM.PV2439 closely compares. In 1927 Hay erected *Neochoerus* for the species. It is morphologically similar to the living *Hydrochoerus,* but of larger size. Capybara remains are common in Florida (Simpson 1930; Webb 1974).

Order Cetacea

Suborder Odontoceti

Family Delphinidae

Tursiops cf. *T. truncatus* (Montague) — Atlantic bottlenose dolphin

Material.—ChM.PV2434, tooth fragment; ChM.PV2430, vertebra; HS.E-34, vertebra.

Family Physeteridae

Physeter sp. (Linnaeus) — sperm whale

Material.—ChM.PV2436, tooth fragment.

Suborder Mysticeti

Family Balaenopteridae, gen. et sp. indet.

A vertebral fragment (ChM.PV2431) and an auditory bulla (ChM.PV2433) represent balaenopterids of indeterminate genus or genera.

Order Cetacea, gen. et sp. indet.

Three vertebral fragments (ChM.PV2318-2320) and two auditory bullae (ChM.PV2435 and HS.A-90) are of cetacean origin, but generic identifications remain to be determined.

Order Carnivora

Family Canidae

Canis dirus (Leidy) — dire wolf

Material.—ChM.PV2282, right mandibular fragment with broken

base of C and P_{2-4}, M_1 preserved; HS.EB-22, LP^4 with fragment of left maxilla attached.

Remarks.—Fossil remains of *Canis dirus* and *Canis lupus* are often confused; however, both Merriam (1912) and Martin (1974) concluded that the two species are distinct. Measurements from the Edisto specimens compare well with measurements provided by Martin (1974), Gillette (1979) and Nowak (1979), but are larger than those provided by Anderson (1968). *Canis dirus* was widely distributed in North America in the Pleistocene and occurred commonly in the Southeast (Guilday et al. 1969; Webb 1974; Gillette 1979).

Urocyon cf. *U. cinereoargenteus* (Schreber) — gray fox

Material.—ChM.PV2736, left ulnar fragment.

Remarks.—Although *U. cinereoargenteus* is an acceptable member of the Pleistocene fauna, this specimen could be Recent. The moderate but not strong degree of mineralization makes age determination of the specimen questionable. Reports of gray fox from the southeastern Pleistocene include several in Florida (Gut and Ray 1963; Arata 1959; Martin and Webb 1974) and one in Georgia (Ray 1967). It would be an expected member of a late Pleistocene fauna.

Family Procyonidae

Procyon lotor (Linnaeus) — raccoon

Material.—ChM.PV2280-2281, two mandibular fragments; ChM.PV2282, right mandibular fragment; ChM.PC2737, left mandibular fragment; ChM.PV2747, right femur; HS.A-34, right mandibular fragment; UGV161, portion of left mandible.

Remarks.—Arata and Hutchinson (1964) examined known *Procyon* material and determined that the Pleistocene species are distinguished only on the basis of variation in size. This variation is similar to the geographic variation in size found in modern *P. lotor.* They thus concluded that known specimens of Pleistocene *Procyon* are conspecific with *P. lotor.* The Edisto Island material compares closely with modern *Procyon.* Fossil *P. lotor* has been reported from various localities throughout eastern and central North America, including numerous records from Florida and at least one from the Ashley River, South Carolina (Hay 1923).

Family Ursidae

Tremarctos floridanus (Gidley) — Florida spectacled bear

Material.—ChM.GPV2019, cast of right mandibular ramus with M_2 (original in private collection of Charles Harshaw, Charleston).

Remarks.—Dental measurements of the specimen fall well within the range of those recorded by Kurtén (1966) and Ray (1967). *Tremarctos floridanus* has been reported from several southeastern localities, in-

cluding Tennessee (Guilday and Irving 1967), northwestern Georgia (Ray 1967), and Florida (Kurtén 1966).

Family Odobenidae

cf. *Odobenus rosmarus* (Linnaeus) — walrus

Material.—Cranial fragment (HS).

Remarks.—This specimen has been tentatively referred to *Odobenus rosmarus* (Ray et al. 1968).

Family Phocidae

cf. *Halichoerus grypus* (Fabricius) — gray seal

Material.—ChM.PV2283, partial right innominate.

Remarks.—This specimen has been tentatively referred to *Halichoerus grypus* (Ray et al. 1968).

Family Felidae

Felis onca augusta (Leidy) — jaguar

Material.—ChM.PV2284, right P^4.

Remarks.—This specimen is the first known occurrence of the species in South Carolina (Ray 1967; Kurtén 1973). Fossil *F. onca* occurs throughout much of the conterminous United States, including localities in Florida (Webb 1974), Tennessee (Guilday et al. 1978), and one in northwestern Georgia (Ray 1967).

Order Proboscidea

Family Elephantidae

Mammuthus cf. *M. columbi* (Falconer) — Columbian mammoth

Material.—ChM.PV2291, right lower molar fragment; ChM.PV2287, left upper molar in two fragments; ChM.PV2288, two molar fragments; ChM.PV2289, lower right molar fragment; ChM.PV2292-2293, two molar fragments; ChM.PV2305, cuboid; ChM.PV2290, molar fragment; ChM.PV2285, right third metacarpal; ChM.PV2286, third phalanx, digit III; HS.101, right lower molar; HS.E-46, molar fragment; HS.102, deciduous molar fragment; HS.102, deciduous molar fragment; UGV149, anterior half of probable RM^3; UGV135a-b, tooth fragments.

Remarks.—Osborn (1942) described 10 genera and 59 species of elephants. Although Osborn's criteria for distinguishing species are still used, most authors have identified only 2 genera and 5 to 6 species as valid. Aguirre (1969) regarded two species, *M. imperator* and *M. columbi,* as valid in North America, but Miller (1971) regarded even these as indistinct. Because *M. columbi* has priority, the Edisto Island material is assigned to that species. The Columbian mammoth is known from numerous localities in the Southeast, including Georgia, South Carolina, and Florida (Hay 1923; Webb 1974).

Family Mammutidae

Mammut americanum (Kerr) — American mastodon

Material.—ChM.PV2294-2295, two RM^3's; ChM.PV2286, RM_3 fragment; ChM.PV2297-2298, molar fragments; ChM.PV2742, unerupted deciduous cheek tooth; ChM.PV2299, right mandible; HS.E-45, deciduous cheek tooth fragment; HS.E-44, cheek tooth fragment; HS.103, molar fragment; UGV148, RM^2; UGV133a-c, tooth fragments; UGV153, section of tusk.

Remarks.—Although Osborn (1936) recorded numerous species of the genus *Mammut,* only *M. americanum* is now generally regarded as valid in the North American Pleistocene (Miller 1971).

Order Proboscidea, gen. et sp. indet.

Material.—ChM.PV2300, ChM.PV2307, four tusk fragments; ChM.PV2303, skull fragment; ChM.PV2306, scapular fragment; ChM.PV2733, vertebral fragment; HS.A-117, HS.A-121, HS.A-27, vertebral fragments; HS.E-26A, HS.A-86, fragmentary metapodials; HS.E-67, phalanx.

Order Sirenia

Family Trichechidae

Trichechus (Linnaeus) sp. indet. — manatee

Material.—ChM.GPV627, rib fragment; ChM.PV2315, ChM.PV2317, ChM.PV2453, ChM.PV2321, four rib fragments; ChM.PV2748, thoracic vertebral fragment; HS.E-75, rib fragment; HS.A-33, right mandible.

Remarks.—*Trichechus* is totally aquatic and prefers sheltered bays or sluggish rivers. They are known to wander far inland in Florida rivers. Simpson (1932) indicated that Pleistocene sirenians commonly occur in inland fresh water deposits of Florida. Pleistocene *Trichechus* remains are known along the Atlantic coast from Maryland to Florida (Simpson 1932).

Order Perissodactyla

Family Equidae

Equus (Linnaeus) sp. indet. — horse

Material.—ChM.PV2331, ChM.PV2449, two LP_1; ChM.PV2332, LP_2; ChM.PV2330, LP_3; ChM.PV2333, LM_1; ChM.PV2334-2335, two LM_2; ChM.PV2336-2337, two RP_2; ChM.PV2338, ChM.PV2448, ChM.PV2451, three RP_3; ChM.PV2339; ChM.PV2340;, ChM.PV2360-2361, ChM.PV2447, four LI^2; ChM.PV2341, LP^1; ChM.PV2342-2343, two LP^3; ChM.PV2446, LM^1; ChM.PV2344; LM^2; ChM.PV2348, LM^3; ChM.PV2345-2346, two RP^3; ChM.PV2347, ChM.PV2445, two RM^1; ChM.PV2450, lower molar fragment; ChM.PV2353-2355, three upper molar fragments; ChM.PV2359, molar fragment; ChM.PV2006, premolar fragment; ChM.PV2349-2352, four upper cheek tooth frag-

ments; ChM.PV2357-2358, ChM.PV2452, three lower cheek tooth fragments; HS.E-33A, HS.A-82, two right ulnae; HS.E-27, distal epiphyses of two radii, ChM.PV2321, right tibia; ChM.PV2413, left tibia and portion of shaft; ChM.PV2329, right pelvic fragment, including acetabulum; ChM.PV2322, right astragalus; ChM.PV2745, calcaneal fragment; ChM.PV2372, 2328, ChM.PV2444, three metapodial fragments; ChM.PV2326, fragment of proximal part of metapodial; ChM.GPV1978, metapodial; HS.E-25, two phalanges; ChM.PV2323-2325, ChM.PV2443, four phalanges; UGV115, LM^1 or LM^2; UGV116, RP^3 or RP^4; UGV117, RM^1, UGV118, LP^2; UGV119, RP^3 or RP^4; UGV124, buccal section of LM^1; UGV125, RP^3 or RP^4; UGV126, lingual section of RM^1 UGV127, LP^3 or LP^4; UGV134, LM^1 or LM^2; UGV113, RM_3; UGV114, LP_2; UGV120, RM_1 or RM_2; UGV121, LM_1 UGV122, LM^1, or LM_2; UGV123, LM_3; UGV122, LM_1 or LM_2; UGV123, LM_3; UGV128, LM_1 or LM_2; UGV129, LP_3 or LP_4; UGV130, RM_1 or RM_2; UGV160, glenoid region of scapula.

Remarks.—The possibility that some of the equid remains are of Recent origin must be considered since *E. caballus* is a modern inhabitant of Edisto Island and permineralization is known to take place at a comparatively rapid rate on the island (O'Kelley 1976). Although the antiquity of the *Equus* material cannot be proven absolutely at this time, three factors indicate that at least most of the remains are Pleistocene. First, the very dark color and strong permineralization of some of the fossils is comparable to that of material from species that definitely became extinct during the Pleistocene. Second, the relative abundance of horse material in the fauna would suggest numerous individuals occurring over a long period of time. Finally, *Equus* is an expected member of the Pleistocene fauna at Edisto Island.

Family Tapiridae

Tapirus Brisson sp. indet. — tapir

Material.—ChM.PV2362, symphyseal fragment of mandible with fragmentary root of RI_2; ChM.PV2363, right upper molar fragment; ChM.PV2364, deciduous RM^1; ChM.PV2365, upper molar fragment; HS.E-68, carpal element; HS.Q, right upper molar fragment; HS.R, right molar; UGV150, LM_1; from the private collection of W. M. Wagner, left mandible with P_3-M_3 present.

Remarks.—The incomplete nature of most of the specimens prevents specific determination.

Order Artiodactyla

Family Tayassuidae

Mylohyus cf. *M. fossilis* (Leidy) — long nosed peccary

Material.—ChM.PV2414, symphyseal mandibular fragment with roots of RI_1, RI_2, RC, LI_1, IC; ChM.PV2499, LM_1; from the private

collection of Mrs. Eddie Gue, RP^3 and one molar fragment.

Remarks.—The limited available *Mylohyus* material prevents definite specific determination. Lundelius (1960) recognized *Mylohyus nasutus* and *M. fossilis,* based on differences in size and geographic distribution. *Mylohyus fossilis* is characterized as a smaller species from eastern North America, while *M. nasutus* is a larger species generally occurring west of the Appalachian Mountains. Ray (1967) did not support Lundelius' conclusions but suggested instead that the variation in size between supposed species of *Mylohyus* is the result of sexual variation within one species. The Edisto Island material compares well with material presently identified as *M. fossilis.* Fossil localities include the Ashley River in South Carolina (Allen 1926), Ladds Quarry, Georgia (Ray 1967), and numerous sites in Florida (Webb 1974).

Family Camelidae

Palaeolama cf. *P. mirifica* (Simpson) — Pleistocene llama

Material.—ChM.PV2411, right distal fragment of humerus; ChM.PV2409, right radius-ulna and associated carpals; ChM.PV2410, metapodial shaft fragment; ChM.PV2407, phalanx.

Remarks.—The metapodial fragment and phalanx conform closely in size and morphology to *Palaeolama mirifica* from the Coleman II locality in Florida. But the two limb elements (ChM.PV2411, ChM.PV2409) seem larger and more massive than comparative *P. mirifica* material. Measurements taken from the radius-ulna are comparable to those recorded by Webb (1974) for *P. mirifica* (Table 3). The species has been reported from Florida (Webb 1974), Texas (Lundelius 1972), and the coast of Georgia (Frey et al. 1975). The record of *Palaeolama* at Edisto Island extends its geographic distribution northward.

Table 3. Comparative measurements (mm) of *Palaeolama* cf. *mirifica.*

	ChM.PV 2409	Webb (1974)
Overall length	508	430-451
Length, olecranon	83	
Articular length	428	
Width, proximal articular surface	75	
Width, midlength - transverse	52	
Anteroposterior	36	
Width, distal end	77	

Family Cervidae

Odocoileus virginianus (Boddaert) — white tailed deer

Material.—ChM.PV2403-2404, antler bases; ChM.PV2405, antler fragment; ChM.PV2456, antler fragment, ChM.PV2749, RM^2 fragment; ChM.PV2750, fragment of right humerus; ChM.PV2406, left radius, HS.A-56, antler tine; HS.E-29, anterior extremity of left mandible; HS.A-58, metacarpal fragment; UGV153, section of right tibia.

Remarks.—All material is identical to modern *Odocoileus virginianus,* but the specimens are dark and well mineralized. Although *O. virginianus* is a common species in the middle to late Pleistocene, the possibility that this material is of Recent origin must be considered since the species is presently a common inhabitant of Edisto Island.

Family Bovidae

Bison cf. *B. antiquus* (Leidy) — Pleistocene bison

Material.—ChM.PV2393, horn core, preserved from basal constriction to core tip; ChM.PV2394, horn core fragment; HS.E-77, horn core fragment; ChM.PV2392, horn core fragment; ChM.PV2389, thoracic vertebra.

Remarks.—Edisto bison material is generally robust and strongly permineralized. Measurements from horn cores (Table 4) compare favorably with *Bison antiquus* (Skinner and Kaisen 1947; Robertson 1974). The remaining *Bison* material lacks diagnostic features and cannot with certainty be referred to species.

Bison sp. — bison

Material.—ChM.PV2376, LP_3; ChM.PV2377, LM_1; ChM.PV2304, left frontal fragment; ChM.PV2408, right mandible; ChM.PV2366, right mandible with P_3 and M_1; ChM.PV2374, right mandible with M_2 and M_3; ChM.PV2375, left mandibular fragment with roots of M_1 and M_2; ChM.PV2372, left anterior mandibular fragment; ChM.PV2372, RM^2; ChM.PV2, atlas vertebra; ChM.PV2397, axis vertebra; ChM.PV2388, sacral vertebra; ChM.PV1, sacral vertebra; ChM.PV2390, cervical vertebra; ChM.PV2391, cervical vertebra; ChM.PV2395-2396, two left tibiae; ChM.PV2398, vertebral fragment; ChM.PV2399, vertebral centrum; ChM.PV2372-2373, proximal fragment of right scapula; ChM.PV2367, right scapular fragment; ChM.PV2368, left scapular fragment, glenoid cavity preserved; ChM.PV2369, proximal fragment of humerus; ChM.PV2370, right humerus; ChM.PV2371, distal fragment of right humerus; ChM.PV2378, shaft of right radius; ChM.PV2379, left radius in two fragments; ChM.PV2380, distal fragment of left radius, ChM.PV2401, partial right innominate; ChM.PV2381, distal fragment of left femur; ChM.PV2382, distal fragment of right femur; ChM.PV2383, proximal fragment of left tibia; ChM.PV2384, right calcaneum; ChM.PV2734, calcaneal fragment; ChM.PV2385, proximal fragment of

Table 4. Comparative measurements (mm) of *Bison antiquus* horn cores, Edisto Island and other localities.

	ChM.PV 2393	ChM.PV 2394	HS E-77	*B. bison*[1]			*B. antiquus*[1]			*B. antiquus*[2]		
				Min.	Ave.	Max.	Min.	Ave.	Max.	Min.	Ave.	Max.
Core length, upper curve, burr to tip	302	370	337	140	186	250	220	281	344	260	276	295
Core length, lower curve, burr to tip	366	440	412	170	233	313	280	336	395	325	327	331
Core circumference	334	—	—	208	235	279	290	320	358	334	361	384

[1]Skinner and Kaisen (1947)

[2]Robertson (1974)

metapodial; ChM.PV2386, proximal fragment of right tibia; HS.A-31, posterior part of right mandible with basal fragment of RM_3; HS.A-105, anterior portion of right mandibular ramus with P_1, P_3, M_1, and M_2; HS.A-30, anterior portion of left mandibular ramus without dentition; HS.E-57, proximal portion of scapula; HS.A-119, distal fragment of humerus; HS.A-108, left radius; HS.E-74, olecranon of ulna; HS.E-70, postzygapophysis of vertebra; HS.A-105, fragment of right ilium with acetabulum; HS.E-55, proximal epiphysis of tibia; HS.A-59, distal epiphysis of left tibia; HS.E-31, distal fragment of fibula; HS.A-60, left calcaneum; HS.E-60, astragalus; HS.A-78, left cubonavicular; HS.A-77, right cubonavicular; HS.E-12, fragment of proximal part of fused metatarsal; HS.A-57, metacarpal fragment; HS.A-114, right metatarsal; HS.E-64, HS.E-67, phalanges; HS.A-63, HS.A-65, HS.A-66, phalanges; UGV146, lower molars; UGV147, right astragalus; UGV151, right femur.

PALEOECOLOGY

In general, knowledge of the paleoecology of an area may be derived from the fossil-bearing sediments, the fossils themselves and palynological studies of the fossiliferous strata. At Edisto Island, only the vertebrates (and only their larger, more durable parts) are available for consideration. As a result data are highly limited and biased. However, some knowledge of the paleoecology can be gained from the recovered part of the vertebrate record. The Edisto Island fauna can be divided into at least four general communities, representing broad habitats in the depositional area:

Marine community.—This community consists of predominantly wide ranging marine species that frequent nearshore areas and occasionally occur in rivers and bays. The crocodile (*Gavialosuchus*), the cetaceans (*Tursiops, Physeter,* and balaenopterids), the gray seal (*Halichoerus*), the walrus (*Odobenus*), and the manatee (*Trichechus*), comprise this community. *Halichoerus, Trichechus,* and *Tursiops* may migrate inland by means of estuaries and consequently be found in association with a primarily terrestrial fauna. But the large size of *Physeter* and the balaenopterid whales precludes any major inland migrations and indicates that deposition of remains of these two taxa must have occurred very near, if not in, a marine environment.

Semi-aquatic terrestrial community.—This community relies upon a permanent source of fresh water such as a stream, marsh, or pond, but some members of the community may spend part or most of their lives beyond the limits of water. Included here are the beavers (*Castor* and probably *Castoroides*), the capybara (*Neochoerus*), the turtles (*Chelydra, Chrysemys,* and *Kinosternon*), *Alligator,* and possibly the glyptodont (*Glyptotherium*). Most of these genera also require substantial amounts of vegetation in or near the water, both for food and for shelter. In particular, the beavers would depend on brush or standing timber in the

area, and alligators would require dense vegetation along stream banks or marsh edges for nest building.

Forest community.—The forest community includes species that depend on forest vegetation and food and/or refuge and spend most of their time in forested areas. The ground sloth (*Megalonyx*), mastodon (*Mammut*), tapir (*Tapirus*), peccary (*Mylohyus*), and sloth (*Eremotherium*) are all considered to be browsers, preferring dense vegetation. *Felis, Odocoileus,* and *Sylvilagus* also prefer the forest habitat. The turtles, *Gopherus* and *Terrapene,* might also frequent forested areas.

Savannah community.—The savannah community is well represented in the fossil fauna and mostly consists of grazers, which rely on tall grasses and scrubby vegetation or open grasslands. Included are the glyptodont (*Glyptotherium*), ground sloth (*Paramylodon*), mammoth (*Mammuthus*), horse (*Equus*), buffalo (*Bison*), and llama (*Palaeolama*). *Terrapene, Geochelone,* and *Gopherus* also occur in savannah type vegetation.

Although most species have been assigned to a particular community, many would regularly visit two or more of the described habitats. For example, the raccoon (*Procyon*) would be expected to frequent stream banks and marshes and to den in a wooded area, but an individual might also wander through open grasslands. The rabbit (*Sylvilagus*), wolf (*Canis*), fox (*Urocyon*), and deer (*Odocoileus*) also commonly move from one habitat to another.

The probable common ground for all species concerned is the watering place. Thus, the fauna gives evidence of a stream or marsh environment bordered by open savannah and scattered wooded areas.

The presence of certain species in the fauna indicates particular climatic restrictions. The most definite climatic limitation is imposed by the presence of *Alligator* and *Geochelone* in the fauna. These occur in tropical to subtropical climates in which temperatures rarely, if ever, fall below freezing and where precipitation is usually plentiful. Thus, at the time *Alligator* and *Geochelone* lived in the vicinity of Edisto Island the climate may have been more equable than the present climate of the area. Other genera that are considered to be restricted to warm, moist climates include *Chlamytherium, Glyptotherium, Neochoerus, Dasypus,* and *Mylohyus.*

Several genera suggest a substantially cooler climate. These include; *Mammut, Castoroides, Halichoerus,* and *Odobenus.* The status of the mastodon with respect to climate is uncertain (Martin and Guilday 1967; Dreimanis 1968; Voorhies 1974); however, their ecological tolerances might reasonably be expected to be broad. *Castoroides* is most commonly found in the Great Lakes region, thus ranging into distinctly northern climates. But the genus also has been reported from southern localities, and no southern climate restrictions have been determined. *Odobenus* and *Halichoerus* are thought of as northern species, but their occurrence

at Edisto may indicate individuals wandering beyond the normal range or a more extended range during the Pleistocene, possibly as a result of a cooler climate.

In the absence of any stratigraphic control there is no evidence that the Edisto fauna is unified. On the contrary, it appears almost certainly heterochronous. Thus, inferences regarding the paleoclimatic conditions cannot be made with any degree of certainty. In general, however, the assemblage appears to reflect a predominantly warm, moist climate similar to or warmer than that of today.

AGE AND RELATIONS OF THE EDISTO VERTEBRATES

The age of the Edisto Island fauna may be established only on the basis of previously recorded biostratigraphic occurrence of the species present.

The most definitive species are *Neochoerus pinckneyi* (restricted to the Wisconsin), *Bison* cf. *antiquus, Dasypus bellus, Glyptotherium floridanus,* and *Canis dirus,* which are Sangamonian to Wisconsinian in age. *Chrysemys scripta petrolei* also is limited to the Sangamonian and Wisconsinian. Although the total span of deposition at Edisto Island certainly may extend well beyond these temporal limits, much of the deposition probably occurred during the Rancholabrean.

The problem of a mixed fauna cannot wholly be resolved. Because of apparent rapid mineralization at Edisto Island, the separation of Pleistocene and Holocene material remains in question. Neill (1957) noted that rapid permineralization may create the illusion that Recent material is of an older age, and cautioned against interpreting all permineralized material as fossils. O'Kelley (1976) dated mammalian fossils, which were eroding out of a marsh clay deposit on the beach and exhibited the characteristic dark color and degree of mineralization of "fossils," but found them to be of Holocene age.

At this point only a partial solution to the problem may be offered. The Edisto Island fauna is composed primarily of species limited to the Pleistocene. Extant species in the fauna are included in the Pleistocene fauna recorded here and are acceptable Pleistocene species, but they must remain suspect as possibly representing a mixture of Holocene and Pleistocene material. Furthermore, the late Tertiary age for *Gavialosuchus* cannot be discounted.

Failure to recover microvertebrates, even after extensive screening, suggests that the absence of the more fragile groups such as small mammals, amphibians, birds and some reptiles is due to transport or possible surf grinding. However, larger vertebrates are well represented. Of a possible 11 mammalian orders, 9 appear in the faunal list.

With the exception of small vertebrates, which are absent from the fauna, the Edisto Island species list is similar to those of several coastal Florida sites of Rancholabrean age. In particular, Edisto Island and

Seminole Field (Simpson 1929b) share 19 mammalian genera; Edisto Island and Melbourne (Ray 1958) share 20. Of the 14 vertebrate species recovered from the Georgia estuaries (Frey et al. 1975), 9 appear at Edisto Island. Although the Edisto Island fauna is in some repects similar to the Ladds Quarry fauna (Ray 1967), Edisto Island lacks the species associated with a colder climate and upland terrain (e.g., *Martes pennanti, Sylvilagus transitionalis,* and large sciurids). However, Edisto Island has several savannah dwelling species (e.g., *Palaeolama, Glyptotherium*) that are not present at Ladds Quarry, in addition to the marine taxa.

The Edisto Island records of *Glyptotherium, Palaeolama,* and *Geochelone* constitute northern range extensions for these genera in eastern North America. In fact, the Charleston region of South Carolina represents the approximate northern limit of the range of other Late Pleistocene taxa including *Tapirus, Mylohyus,* and *Neochoerus.*

The taxa occurring at Edisto Island in the Late Pleistocene represent essentially a coastal plain assemblage similar to late Pleistocene faunas found throughout Florida and the Gulf coastal region at least as far west as Texas (Lundelius 1972).

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The Status of *Cleptoria shelfordi* Loomis, with the Proposal of a New Genus in the Milliped Family Xystodesmidae (Polydesmida)

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ABSTRACT.—The new xystodesmid milliped genus *Brevigonus* is proposed to accommodate *Cleptoria shelfordi* Loomis. It is monotypic and distinguished by the brevity of the male gonopods, which *in situ* extend barely beyond the margin of the aperture. Two basic gonopodal variants of *B. shelfordi* exist, labeled A and B, but they do not appear to be reproductively isolated, and their sympatric ranges likewise rule out subspecific status. Variant A possesses an enlarged medial flange on the acropodite and a basal telopodal spine, whereas in variant B the spine is absent and the flange is reduced. Variant B, however, displays a prominent medial spur on the acropodite which is absent or greatly reduced in variant A. The two variants also differ in the curvature of the acropodite and its apical configuration. *Brevigonus shelfordi* occurs in a narrow band along the north side of the Savannah River in the Piedmont Plateau of South Carolina, from the vicinity of Clemson to McCormick. It has not been found across the river in Georgia, where the dominant xystodesmid is *Cleptoria abbotti* Hoffman.

In 1942 and 1943 Professor V. E. Shelford of the University of Illinois collected millipeds in the southeastern United States and sent them to H. F. Loomis, who published the results of the survey (Loomis 1944). He described three new xystodesmid species, one of them named for Prof. Shelford and assigned to the genus *Cleptoria,* probably because of its large size, the triangular prefemoral process of the male gonopod, and the general appearance of the telopodite. Since its description, *Cleptoria shelfordi* has been mentioned in only two other taxonomic publications. The first was the North American checklist (Chamberlin and Hoffman 1958), which merely cited the species and incorrectly reported the type locality (the De La Howe Forest) as being in Lincoln County, Georgia. It is actually across the Savannah River in McCormick County, South Carolina, approximately 11.3 km (7 mi.) west of the town of McCormick. The second reference was Hoffman's (1967) revision of *Cleptoria,* in which he transferred *shelfordi* to "another generic group so far unpublished." Thirteen years later this genus is still unpublished, and technically *shelfordi* has no generic name, a most awkard nomenclatorial situation.

The *shelfordi* problem has interested me since I examined the holotype in connection with a study of abnormal xystodesmids (Shelley 1977). The eighth segment of this milliped is without legs or a sternum (Fig. 1), a condition unreported at that time in the Diplopoda. Of further interest, however, was the contrast between the large size of the *shelfordi* type and the brevity of the gonopods, which were the shortest I had seen on an aphelorine xystodesmid and seemed almost aborted. Because of this specimen and the nomenclatorial problem, I visited the type locality in 1976 and found congeneric material in a 64 km (40 mi.) section along the north side of the Savannah River in Abbeville and McCormick counties. I investigated habitat on both sides of the river, but found pertinent forms only in a narrow strip, 32 km (20 mi.) wide, on the South Carolina side. One male from Oconee County is present in Hoffman's collection, but field trips to this area and Anderson County have been unproductive. Superficial examination revealed that *shelfordi* requires a new genus, and I propose the name *Brevigonus* to emphasize this feature of the male genitalia. Still unresolved is the number of species comprising the taxon, and I have conducted meticulous field surveys to try to find out. My current conception of a monotypic genus may eventually be altered, since two basic gonopodal variants are evident in the material at hand. They share more features than most aphelorine congeners, however, and thus seem not to be reproductively isolated. Moreover, they occur sympatrically throughout the range of the genus, and I know of no aphelorine genus in which all the species occur over the entire range. Sampling to date has been thorough, and additional collecting will probably not further clarify the situation. Consequently, I recognize only one species in *Brevigonus,* and the present contribution is offered mainly to redescribe *shelfordi* and to provide it with a generic name.

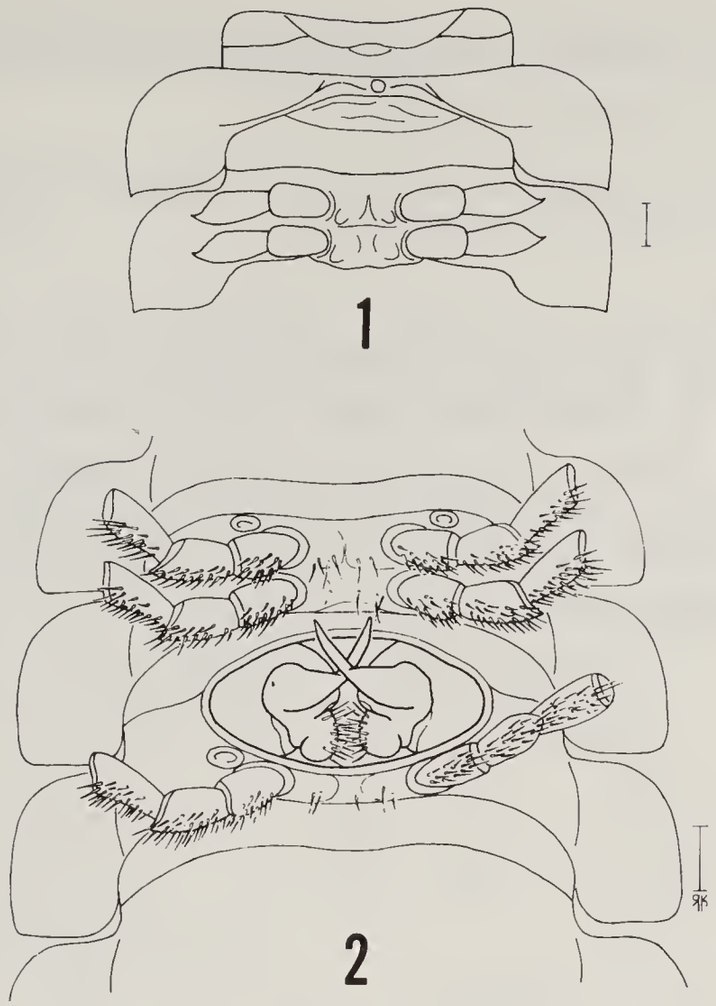
Brevigonus, new genus

Type species.—Cleptoria shelfordi Loomis, 1944.

Description.—A genus of large, robust xystodesmids with the following characteristics:

Body composed of head and 20 segments in both sexes; W/L ratio 22-24%. Head of normal appearance, smooth, polished; epicranial suture distinct, not bifid; facial setae reduced, epicranial and interantennal absent. Antennae relatively short, with four antennal cones.

Terga smooth, polished. Collum large, broad, extending slightly beyond ends of following tergite on each side. Paranota moderately depressed, continuing slope of middorsum; peritremata flat on anterior-



Figs. 1-2. 1, *B. shelfordi* holotype, segments 8 and 9, ventral view. 2, topotype, segments 6 and 7, ventral view. Scale lines = 1.00 mm.

most segments, becoming more distinct and elevated in midbody region; ozopores opening dorsad.

Caudal segments normal for family.

Sterna variable with large process on segment 4 and two small structures between both pairs of legs on segment 5. Postgonopodal sterna a modification of bilobed variation discussed by Hoffman (1965). Female sterna similar to postgonopodal sterna of males.

Gonopodal aperture subelliptical. Gonopods overlapping *in situ,* extending forward just beyond anterior margin of aperture. Coxae massive, without apophyses, connected by membrane only, no sternal remnant. Prefemora of normal size, usually with large, cuneate processes arising on dorsal sides. Acropodites extremely short, curving broadly distad to prefemora, apically blunt, with or without a variable medial flange, spur, and basal spine.

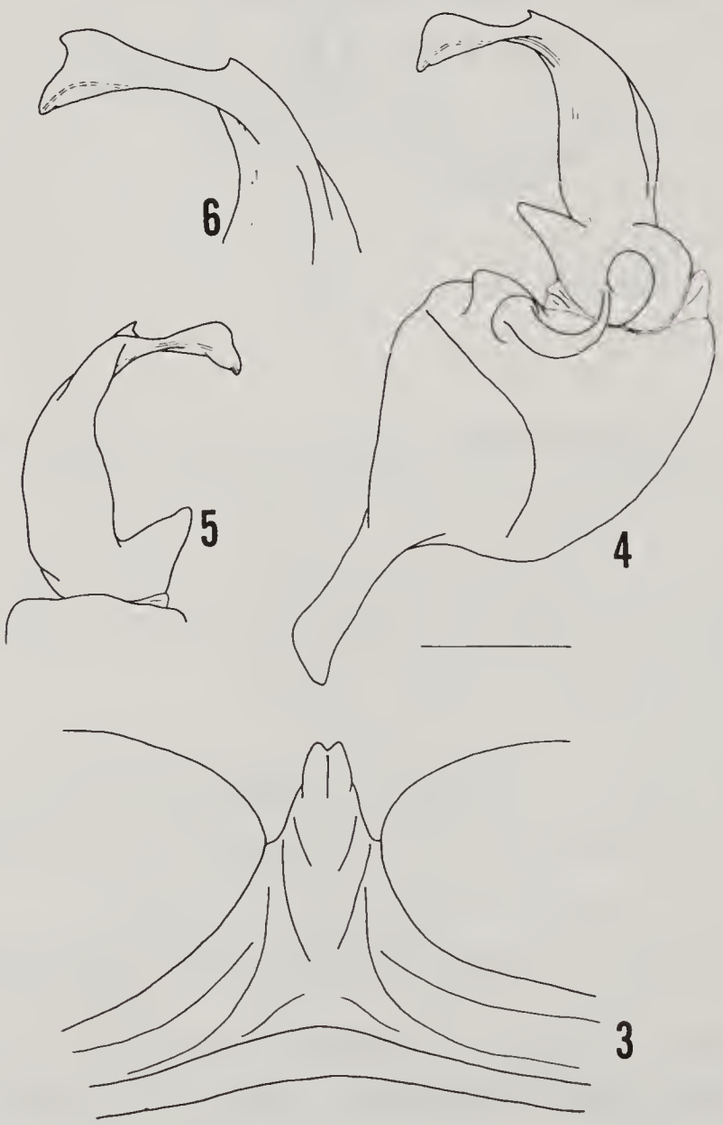
Cyphopodal aperture rounded, situated lateral to second legs. Cyphopods large, with receptacle and tips of valves visible *in situ.*

Receptacle large, convoluted, cupped around ventral edges of valves; valves elongate, oriented subdorsoventrally in body; operculum minute, located under dorsal end of valves.

Range.—Along Savannah River in piedmont South Carolina from the vicinity of Clemson to McCormick.

Species: One

Relationships.—Brevigonus is most closely related to *Cleptoria.* The acropodite of the latter also is rather short, and this plus the common wedgeshaped prefemoral processes and the massive nature of the gonopods indicate close affinity between the two genera. I believe that *Brevigonus* evolved more recently than *Cleptoria* and that it may be derived from that genus.



Figs. 3-6. *B. shelfordi* holotype. 3, sternal process of segment 4, caudal view. 4, left gonopod, medial view, setation omitted. 5, same, lateral view. 6, topotype, distal portion of acropodite, medial view. Scale line = 1.00 mm for Figs. 4-5, 0.67 mm for Figs. 3 and 6.

Brevigonus shelfordi (Loomis), new combination
Figs. 1-14

Cleptoria shelfordi Loomis, 1944:172-173, Fig. 4. Chamberlin and Hoffman, 1958:28.

Type specimen.—Male holotype, Museum of Comparative Zoology (MCZ), collected by V.E. Shelford, 10 July 1942, from station 11, De La Howe Forest, McCormick Co., South Carolina.

Diagnosis.—With the characters of the genus.

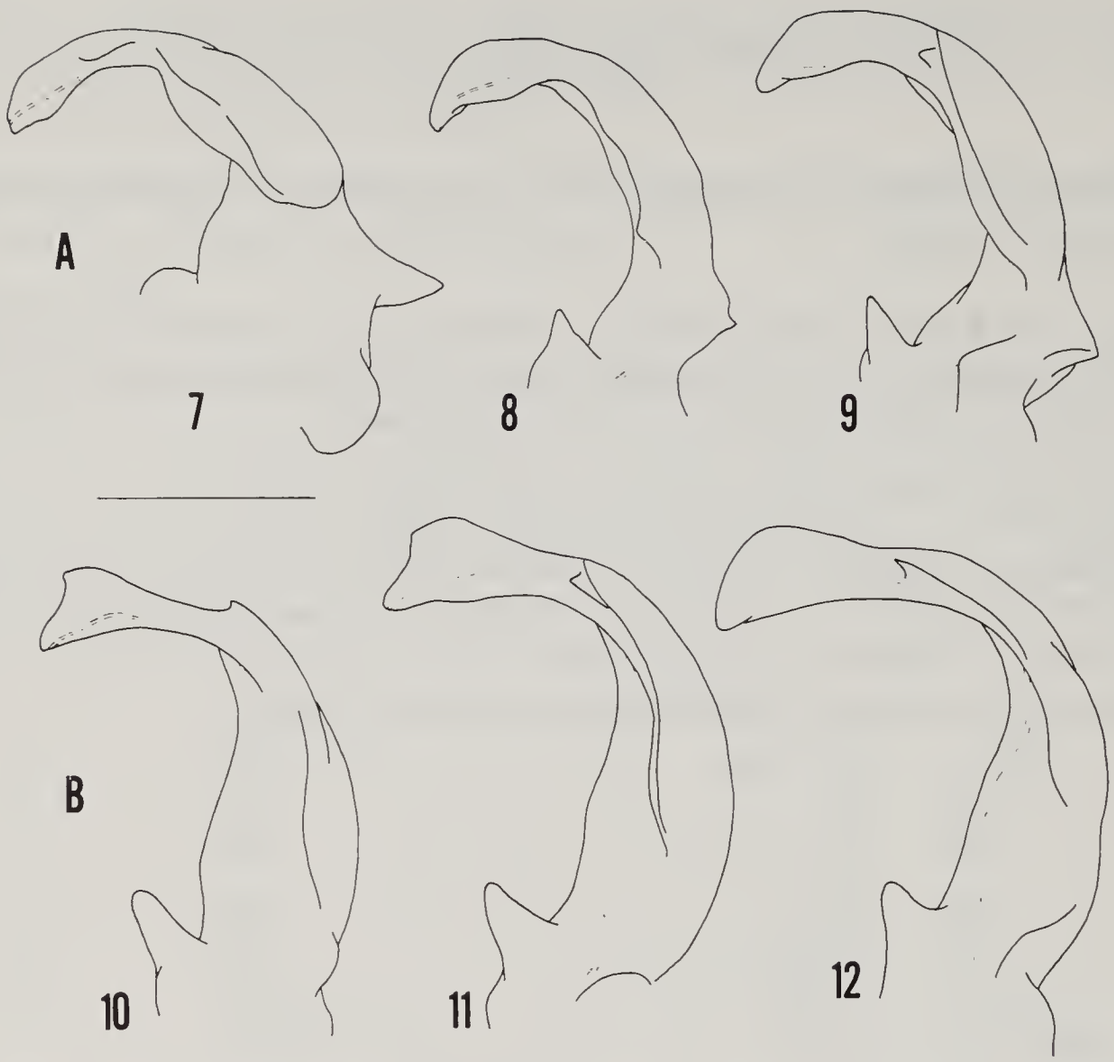
Holotype.—Length 56.1 mm, width 13.0 mm, W/L ratio 23.2%. Paranota depressed, creating a high height/width ratio of 60.3% at mid-body. Body essentially parallel sided from segments 6-14, tapering at both ends as indicated by following segmental widths:

collum	8.7 mm	12th-13th	13.0
2nd	9.7	14th	12.8
3rd	10.8	15th	12.2
4th	11.6	16th	11.4
5th	11.9	17th	9.4
6th-9th	12.0	18th	6.9
10th-11th	12.8		

Color in life unknown (see topotype description). Head capsule smooth, polished; width across genal apices 5.4 mm; interantennal isthmus broad (1.9 mm), smooth; epicranial suture shallow but distinct. Antennae relatively short, extending only to caudal edge of second tergite, becoming progressively more hirsute distally; first antennomere subglobose, 2-6 clavate, 7 short and truncate; relative lengths of antennomeres as follows: 2 > 3 > 4 > 6 > 5 > 1 > 7. Genae not margined laterally, trace of medial impression, ends broadly rounded and extending slightly beyond adjacent cranial margins. Facial setae as follows: frontal 1-1 (impressions only, setae not seen), genal 1-1, clypeal about 9-9, labral about 12-12.

Dorsum typical for family. Paranotal corners rounded on segments 1-6, becoming slightly more distinct on 7 and progressively more so caudally. Peritremata virtually flat on segments 1-7, only slightly elevated above paranotal surface; higher and more distinct on remaining segments. Ozopores small and indistinct, situated near middle of paranota.

Sternum of segment 4 produced into large, apically divided process (Fig. 3), subequal in length to width of adjacent coxae; sternum of segment 5 produced into two small digitiform lobes between fourth pair of legs and two knoblike processes between fifth pair. Postgonopodal sterna



Figs. 7-12. Gonopodal variation in *B. shelfordi,* medial views of acropodites of specimens from selected localities for variants A and B, as discussed in text. 7, Oconee Co., Clemson vicinity. 8, Abbeville Co., 4.8 km sw of Calhoun Falls near Savannah River. 9, McCormick Co., Hickory Knob State Park. 10, topotype, McCormick Co., 11.6 km wnw of McCormick, De La Howe Forest. 11, Abbeville Co., 10 km s of Abbeville, along road to Parsons Mountain campground, Sumter National Forest. 12, McCormick Co., Baker Creek State Park. Scale line = 1.00 mm for all figures.

elevated behind stricture, interrupted by transverse groove behind first pair of legs on each segment, expanded into broad platelike structure beyond caudal legs with shallow medial depression, small blunt lobes subtending anterior legs of each segment, larger rounded lobes beside caudal legs. Hypoproct broadly rounded, subacute distally, two paramedial setae arising from distinct rounded tubercles. Paraprocts with margins strongly thickened. Coxae generally without spines, low blunt "teeth" present on postgonopodal legs; prefemoral spines distinct on postgonopodal legs; tarsal claws darkened distally, bisinuately curved. Segment 8 without any trace of legs or sterna, teratological, caudal edge of metazonite broadly indented along midline (see Shelley 1977).

Gonopodal aperture subelliptical, about 3.9 mm long and 2.5 mm

wide at midpoint; margins not raised, smoothly continuing sternal slope, thickened along caudal edge. Gonopods (Figs. 4-5): prefemoral process short and subtriangular, cuneate; acropodite widest at base, expanded into flange along medial edge which terminates in short spur about midlength of acropodite; acropodite constricted and broadly curved cephalad at midlength, apically expanded and flattened, with rounded subterminal lobe on dorsal edge, subacute apically; prostatic groove crossing over from medial to lateral sides at midlength curvature, opening apically.

Topotypes.—The topotypes are glossy black dorsally with red paranota and a suggestion of a stripe along the anterior edge of the collum. The metaterga, however, are without stripes. As shown in Figure 6, the gonopods of some topotypes differ from those of the holotype, being distinctly forked apically with a hoodlike lobe overhanging the solenomerite. There is only a trace of this indentation in the holotype. The brevity of the gonopods is most clearly revealed *in situ* (Fig. 2), where they overlap each other and extend barely beyond the anterior edge of the aperture. Cyphopods (Fig. 13) of female topotypes as described for genus.

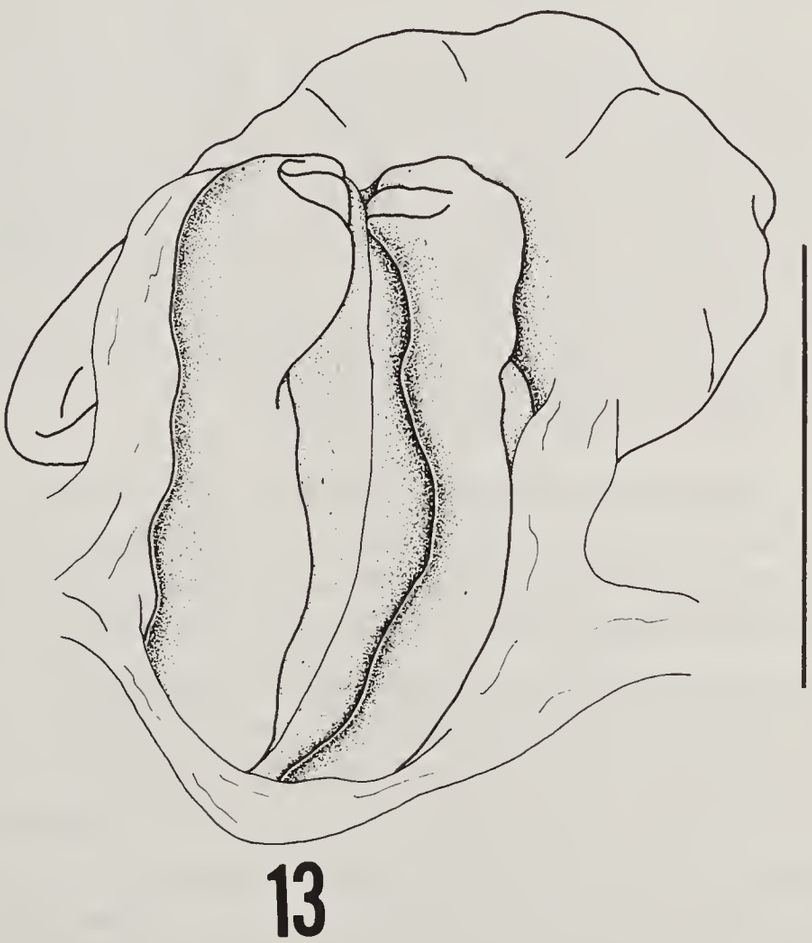


Fig. 13. Right cyphopod of female topotype, lateral view. Scale line = 1.00 mm.

Variation.—The only color variation involves the presence or absence of a narrow red stripe along the anterior edge of the collum connecting the paranotal spots.

As mentioned in the introduction, two basic gonopodal variants exist. In variant A (Figs. 7-9) the flange of the gonopod is greatly enlarged, partially or completely obscuring the stem of the acropodite in medial view. This condition is accompanied by a prominent basal spine on the ventral side of the acropodite; reduction of the medial acropodite spur, which is absent from some specimens (Figs. 7-8); and a more compact curvature of the acropodite in which the tip is directed dorsad or downward toward the coxa in medial view. In variant B (Figs. 10-12), which includes material from the type locality, the basal spine is absent and the flange is reduced so that the prostatic groove is visible in medial view to about the point where it crosses to the lateral side of the acropodite. The spur is distinct in all these specimens, and the acropodite extends cephalad apically with the tip directed only slightly dorsad. The prefemoral process varies more in variant A than in B, and is missing from the male from Oconee County (Fig. 7). Likewise, the apical indentation of the acropodite occurs only in variant B (Figs. 10-11), but as shown in Figure 12 it is not present on all specimens. In both groups the gonopods are large and heavily sclerotized. These two variants are intermixed and occur throughout the range of *shelfordi,* but the presence of characters from each variant in the other (e.g., the spur of B in A, Fig. 19, and the apical configuration of A in B, Fig. 12) suggests that they are not reproductively isolated. Their sympatric ranges argue against subspecific recognition, and the only alternative is a single species with variable gonopods. Should future discoveries justify taxonomic recognition of the two groups, the name *shelfordi* will be available for variant B, and a new specific name will be required for variant A.

Ecology.—Brevigonus shelfordi usually is found under thin layers of leaves on relatively hard substrates near water sources; the male from Oconee County was discovered under a dead pig. This region of South Carolina is predominantly pine, and hardwoods are typically found only along creeks and rivers. The type locality is an exception, however, and the species is abundant in the protected forest tract near the grave of John De La Howe. Visits to this site in August 1976 and May 1977 produced 7M, 4F, and 7M, 2F, respectively, and many times these numbers could have been taken. The area is hilly, and *shelfordi* occurs in thick leaf piles, in open litter, under logs, and on banks of creeks. The following description of the De La Howe forest is excerpted from Radford and Martin (1975:182).

> The De La Howe woods is the "progenitor" of all piedmont forests. The canopy is dominated by loblolly pines on the slopes and in the draws with shortleaf pine on the ridges with several age classes and trees 12-42" D. B. H. The subcanopy is a mosaic of oaks and cover hardwood elements . . . On the ridges and slopes are red, white, black, post and southern red oaks along with pignut and mockernut hickories, red mulberry, yellow poplar and sweet gum; in the draws and sheltered slopes are beeches and southern sugar maple. Most of the subcanopy trees vary from 12-24" D. B. H. Beneath the subcanopy is a layer of hop hornbeam, storax and flowering dogwood along with some tall blue haws (*Viburnum prunifolium*). The shrub layer is composed of leatherwood in the draws, dwarf pawpaw, aromatic sumac, and maple-leaved viburnum on the slopes and deerberry (*Vaccinium stamineum*) and New Jersey tea along the ridge. . . . the herb layer is scant with the woody layers above but it is a unique combination of partridge berry, wintergreen and pennywort (*Obolaria virginica*).
>
> This is a classic example of the eastern North American Oak-Pine Forest with a maximum woody plant diversity. Tree size for the age of the stand is not overly impressive but the combination of woody species over this nearly circumneutral soil derived from a basic igneous rock and the abundance of the *Obolaria* make this a truly outstanding site.
>
> The tract is now recognized as a Natural Area by the Society of American Foresters.

Distribution.—Brevigonus shelfordi ranges about 112 km (70 mi.) along the north side of the Savannah River in piedmont South Carolina, from the vicinity of Clemson to McCormick. It occurs about 32 km (20 mi.) from the river into South Carolina, but most individuals have been collected less than 16 km (10 mi.) from the river in Abbeville and McCormick counties. The species has not been encountered in Anderson County and does not appear to occur in Georgia. I have collected along the Savannah River in Hart, Elbert, Lincoln, and Columbia counties, the Georgia counties bordering the range of *shelfordi,* without finding the milliped. The dominant xystodesmid in this area is *Cleptoria abbotti* Hoffman, which seems to replace *shelfordi* south of the Savannah River. In July 1979 an assistant and I collected *shelfordi* along South Carolina highway 72 in Abbeville County close to the Savannah River, but just across the river in essentially the same habitat in Elbert County, Georgia, we found only *C. abbotti.* I thus feel that *shelfordi* is absent from Georgia even though this area has not been sampled as thoroughly as have areas in South Carolina.

Specimens have been examined from the following South Carolina localities. Unless otherwise indicated, all were collected by the author and deposited in the N. C. State Museum collection, the invertebrate catalogue number of which is shown in parentheses. Materials from the

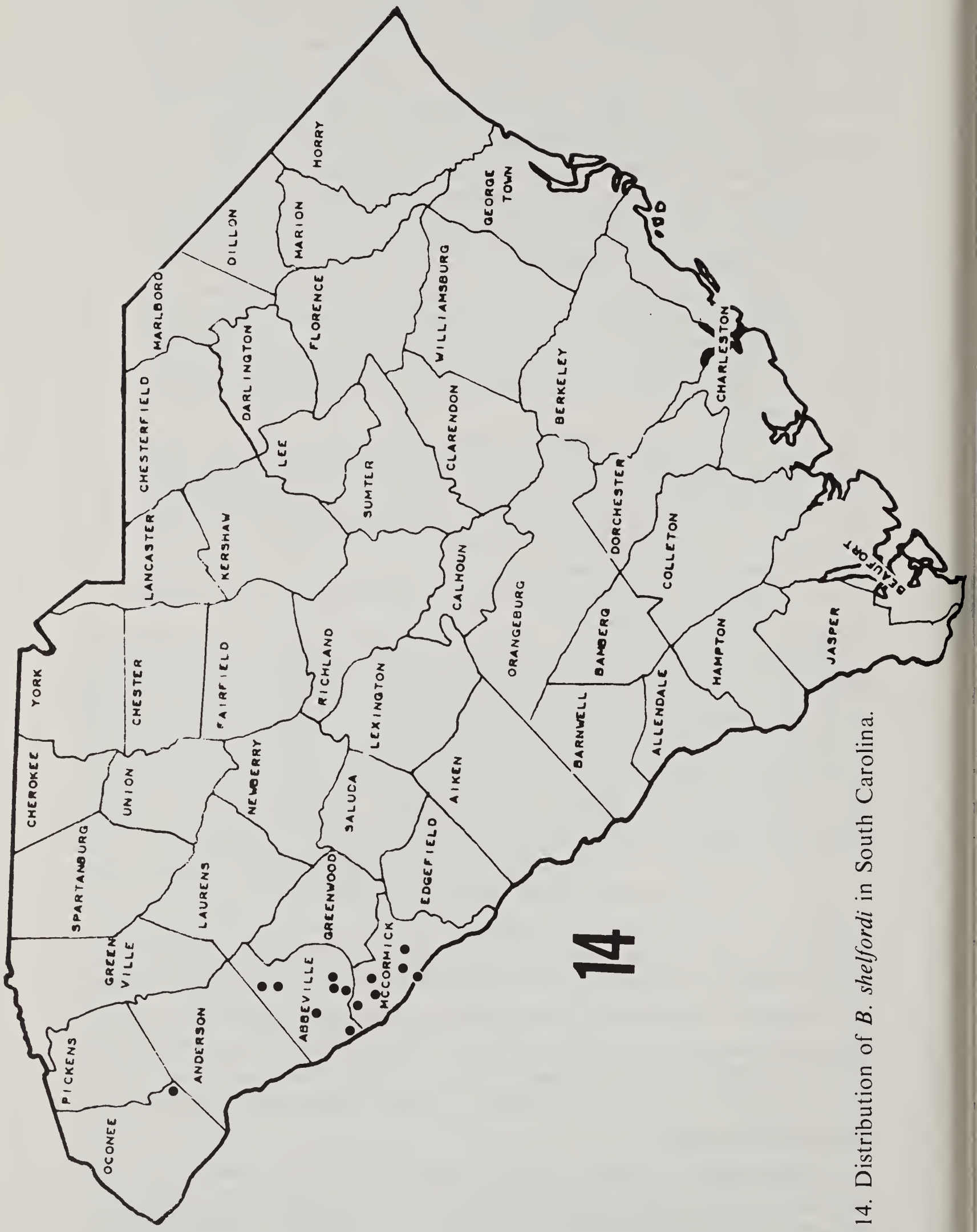


Fig. 14. Distribution of *B. shelfordi* in South Carolina.

Florida State Collection of Arthropods and the private collection of Richard L. Hoffman are indicated by the acronyms FSCA and RLH, respectively, and MCZ is the Museum of Comparative Zoology.

Oconee Co.—Clemson vicinity, under dead pig, 2M, F, 18 July1962, J. A. Payne (RLH). *Abbeville Co.*—5.8 km w of Due West, along SC hwy. 37 at Little River, M. F, 11 June 1978, R .M. Shelley and W. B. Jones (A2067). 10.8 km w of Abbeville, along SC hwy. 71 at Penny Creek, 2M, 6 May 1977 (A1546). 10 km s of Abbeville, Sumter National Forest, along road to Parsons Mountain campground, M, 3F, 9 August 1976 (A1390); Parsons Mountain campground, M, 3F, 10 August 1976 (A1392); and near Parsons Mountain Lake, M. F, 6 May 1977 (A1548). 4.8 km sw of Calhoun Falls, near Savannah River, M, 30 April 1960, L. Hubricht (RLH); 3.8 km sw of Calhoun Falls, along SC hwy. 72, 0.9 km n of Savannah River, 3M, F, 6 May 1977 (A1543), and M, 19 July 1979, R. M. Shelley and R. K. Tardell (A2837). *McCormick Co.*—6 km n of Mt. Carmel, along SC Hwy. 79 at Swaney Creek, 2M, F, 5 May 1977 (A1540). 15 km nw of McCormick, along SC hwy. 39 at Little River, M, 5 May 1977 (A1539). 10.6 km nw of McCormick, jct. SC hwys. 28 and 81, 2M, 5 May 1977 (A1538). 12 km wnw of McCormick, De La Howe Forest, Station 11, M, 10 July 1952, V. E. Shelford (MCZ); De La Howe Forest at end SC hwy. 25, 3.5 km s of jct. SC hwy. 81, 7M, 4F, 9 August 1976 (A1388), and 7M, 2F, 5 May 1977 (A1536), TYPE LOCALITY. 8 km w of McCormick, along US hwy. 378, M, 2 July 1958, collector unknown (FSCA). Baker Creek State Park, M. F, 8 August 1976 (A1386). Hickory Knob State Park, 4M, 3F, 8 August 1976 (A1387).

Remarks.—Brevigonus shelfordi is the largest aphelorine xystodesmid species. Many individuals are comparable in size to *Pachydesmus crassicutis* (Wood) in the tribe Pachydesmini, which attains a length of over 60 mm and is generally considered the largest polydesmoid species in the United States.

ACKNOWLEDGMENTS.—I am grateful to Herbert W. Levi, Museum of Comparative Zoology, for the privilege of examining the holotype of *Cleptoria shelfordi.* Howard V. Weems, Jr., kindly loaned material in the Florida State Collection of Arthropods, and Richard L. Hoffman, Radford College, did likewise with material in his collection. Specimens from Baker Creek and Hickory Knob State Parks were collected with permission of the South Carolina Department of Parks, Recreation, and Tourism. Thanks are also extended to John E. Cooper, N.C. State Museum, for prepublication review and Renaldo G. Kuhler, N.C. State Museum, for preparing Figures 1 and 2. This study was sup-

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Recent Range Expansion of the Groundhog, *Marmota monax*, in the Southeast (Mammalia: Rodentia)

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ABSTRACT.—In recent years the groundhog, *Marmota monax,* has greatly expanded its range in the Southeast and now is found in areas of the Piedmont Plateau and Coastal Plain where it did not occur in historical times. This change in distribution is believed to correlate with changing land use practices.

The groundhog, *Marmota monax,* is generally distributed throughout northeastern North America. South of Pennsylvania and New Jersey it was until recently known mostly from Piedmont Plateau and montane areas. Paradiso (1969) indicated its apparent absence from the Delmarva Peninsula and perhaps most of the Coastal Plain of Maryland. In Virginia, Handley and Patton (1947) reported it to be most common in the mountains, although they had many Piedmont and several Coastal Plain records. Bailey (1946) noted that groundhogs were "scarce" in the "tidewater region" of Virginia. In the Carolinas, *Marmota* has been reported only from mountainous regions (Brimley 1944-46; Golley 1966; Hall and Kelson 1959). This note documents its recent expansion in the Piedmont Plateau of North Carolina and in the Coastal Plain province of Maryland, Delaware, and North Carolina.

Between 1970 and 1977 we compiled Delmarva records for *Marmota*. Data for North Carolina were obtained from a 1974 questionnaire on the distribution of the groundhog that went to all field personnel of the North Carolina Wildlife Resources Commission and from recent records compiled by the North Carolina State Museum (NCSM). The questionnaires are on file in the Department of Mammalogy and Ornithology, NCSM, and voucher specimens from the areas discussed are in the museum's mammal collections.

DELMARVA PENINSULA

Paradiso (1969) noted that *M. monax* was in all sections of Maryland "except the Eastern Shore, where it has until lately been unknown. There is recent evidence, however, that the species is extending its range into that section." Grizzell (1955) reported that it first appeared on the Delmarva at the turn of the century, spreading from Pennsylvania, and by 1955 populations had increased sufficiently to be a probelm in

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some areas. However, neither author had new records for the region east of the Chesapeake Bay. Allen (1950) reported that the species had invaded the Delmarva in the previous 50 years, noting that it first appeared near Galena, Kent County, Maryland, around 1900. This is apparently the only published report of its occurrence east of Chesapeake Bay. Casual interviews with residents of the area confirmed to us that groundhogs had recently appeared there, although agreement on the length of time they had been established was lacking.

It is interesting that we have few records from south of Talbot and Caroline counties, Maryland, and Kent County, Delaware, despite intensive field work. This may reflect the change in soil composition which occurs in this general area. The well-to-poorly drained sandy loam and sandy clay loam soils (Sassafras and Sassafras-Fallsington associations), which are nearly continuous in the northern portion of the Delmarva, become fragmented here. The 75- to 125-cm deep loamy soils are mostly replaced by more sandy soil associations, and much of the area is dissected by extensive *Spartina* marshes which would further limit dispersal of *Marmota.*

The southern limits of the groundhog on the Delmarva appear to terminate at the northern limits of pure stands of Loblolly Pine, *Pinus taeda* (Conant 1945). This change in community character appears to have effectively limited the natural dispersal of several vertebrate species: the Whip-poor-will, *Caprimulgus vociferus,* and Scarlet Tanager, *Piranga olivacea* (Stewart and Robbins 1958); and the Red-spotted Newt, *Notophthalmus viridescens viridescens,* Spotted Salamander, *Ambystoma maculatum,* Northern Red Salamander, *Pseudotriton ruber ruber,* and Northern Two-lined Salamander, *Eurycea bislineata bislineata* (Harris 1975). Also, disjunct populations of at least six species of upland plants occurring in communities of Coastal Plain hardwoods on the peninsula are excluded from areas which support extensive stands of *P. taeda* (Franz and Lee 1976).

Delaware Records

Coastal Plain: *New Castle County.*—Road shoulders/fields, 3 mi. (4.8 km) s of Middletown on SR 896; 1973 (Matapeake-Sassafras soil type). Road shoulders/hardwood forest, 8 mi. (12.9 km) n of Smyrna on US 13; 1973 (Matapeake-Sassafras). Fields, Lums Pond State Park; 1974. US 301 between Summit and Middletown; 1972. *Kent County.*—Dikes/fields, Bombay Hook National Wildlife Refuge; 1974-1976. Fields, 7 mi. (11.3 km) s of Leipsic on SR 9; 1976 (NCSM 2933). *Sussex County.*—Fields, Prime Hook Wildlife Refuge; 1974 (sandy loam).

Maryland Records

Piedmont Plateau: *Cecil County.*—River floodplain, Conowingo and Rt. 222, 5 mi. (8.1 km) s of Conowingo; 1968-73. Rising Sun; 1969.

Coastal Plain: *Cecil County.*—Chesapeake City; 1941 (NCSM 1997). *Kent County.*—Galena (Allen 1950). Fields, Rock Hall; 1973. Eastern Neck National Wildlife Refuge; 1972. *Talbot County.*—Fields, 3 mi. (4.8 km) east of jct. SR 404 and 309; 1973. Hardwood forest, Mill Creek Sanctuary, 8 mi. (12.9 km) east of Easton; 1973. *Queen Annes County.*—Centerville; 1974. *Caroline County.*—Fields, Denton; 1973.

NORTH CAROLINA

The distribution of the groundhog in the North Carolina Piedmont Plateau and Coastal Plain is undergoing a transition similar to that observed in Maryland and Delaware. In the western Piedmont of the state groundhogs are now known from Gaston, Cleveland, Catawba, Iredell, Davie, Forsyth, and all counties farther west. In the central Piedmont they occur through Guilford, Randolph and Alamance counties, as well as in the tier of counties along the Virginia border — Surry, Stokes, Rockingham, Caswell, Person and Granville. The individuals forming the presently small, scattered Piedmont populations probably represent immigrants from western North Carolina and adjacent counties in Virginia. The construction of two large reservoirs on the North Carolina-Virginia border (Kerr Reservoir and Lake Gaston) may have facilitated movement of the groundhogs into North Carolina as massive areas were cleared prior to flooding.

Populations in Orange and Durham counties appear to date from the early 1950s, when 13 animals from the western part of the state were released near Hillsborough, Orange County (NCSM files). Specimens and sight records from Wake County perhaps represent an expansion of this population.

Groundhogs also have expanded into the northeastern Coastal Plain counties of North Carolina, where they are primarily distributed along rivers and larger streams—the Neuse River in Greene County and Meherrin River in Hertford County, the Roanoke River in several counties, the Tar River in Nash and Edgecombe counties, and the Chowan River in Gates and Chowan counties. The Roanoke and Tar river areas appear to have been colonized first, and our earliest Coastal Plain records are from Halifax and Nash counties. There are now populations from eastern Vance County through Warren, Halifax, Northampton, Hertford, Gates, Chowan, Bertie, Martin, Edgecombe, Nash, Wilson, Johnston and Greene counties. The Coastal Plain groundhogs typically build their burrows in streambanks and along drainage ditches as well as at the edges of open fields. The levees along the Roanoke River, in particular, contain a large number of burrows.

North Carolina Records

Piedmont Plateau: *Davie County.*—Mocksville; 1975. *Durham County.*—10 mi. (16.1 km) n of Durham on US 501; 1979. *Franklin*

County.—Lynch Creek, 0.24 mi. (0.39 km) from SR 1240; 1977 (Appling-Cecil sandy loam). *Gaston County.*—Shoulder of US 321, between Gastonia and Dallas; 1956 (Appling-Cecil sandy loam). *Granville County.*—Fields, Critcher Farm near Stovall; 1974 (Herndon-Georgeville silt loam or silty clay loam). Pasture, Butner; 1971. *Iredell County.*—9 mi. (14.5 km) e of Statesville on US 40, 1979. *Orange County.*—13 specimens from mountains released; 1950. Eno River State Park (NCSM 2675); 1977. Hillsborough (NCSM 2676); 1975. *Wake County.*—Urban Raleigh; 1939, and (NCSM 3026, 3062); 1976. 10 mi. (16.1 km) e of Raleigh; 1950 (Appling-Cecil sandy loam). Cary; 1977. *Warren County.*—I-85 at SR 1210; 1977 (Granville-White Store sandy loam). 3 mi. (4.8 km) n of Wise near US 1 on highway shoulder; 1976 (Appling-Cecil sandy loam).

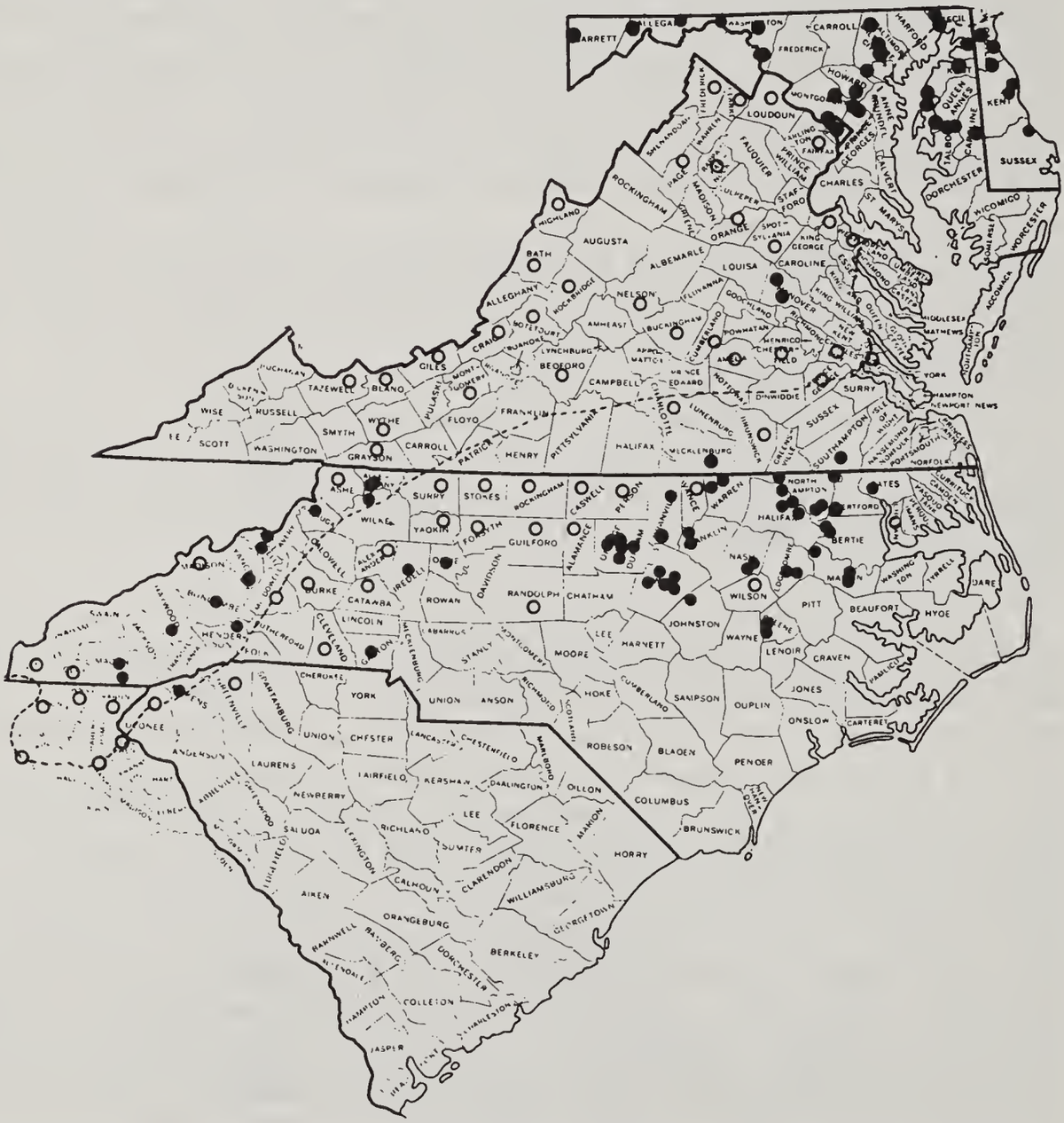

Fig. 1. Distribution of *Marmota monax* in the Southeast. Dashed line indicates approximate eastern limit of historical range. Solid symbols are specific locality records; hollow symbols are county records only. Compiled from Golley 1962, 1966; Hall and Kelson 1959; Handley and Patton 1947; Paradiso 1969; and NCSM records.

Coastal Plain: *Bertie County.*—Old homestead, 200 yd. (182 m) from Roanoke River near Woodville; 1975 (terrace soils—loamy sands to clay loams). Levee along Roanoke River near Kelford; 1976 (Dunbar-Lynchburg sandy loam). *Edgecombe County.*—Downtown Tarboro under building; no date. *Gates County.*—Peanut fields, US 13 near Storey's crossroad; 1973 (Craven-Shubuta sandy loam). *Greene County.*—8 mi. (12.9 km) w of Snow Hill; 1972 (Craven-Shubuta sandy loam). *Halifax County.*—Levees along Roanoke River at Weldon; 1971-75 (alluvial soils). *Hertford County.*—Burrow under bridge abutment 0.7 mi. (1 km) s of Menola on SR 1150; 1973 (silt loam). *Johnston County.*—Clayton (NCSM 256); 1951. *Martin County.*—Swimming in Roanoke River near Jamesville; 1973 (terrace soils—loamy sands to clay loams). *Nash County.*—Surburban area west side of Rocky Mount; ca. 1948 (Norfolk-Ruston sandy loam). Shoulder NC 43; 1970 (Norfolk-Ruston sandy loams). *Northampton County.*—Levees and brushy fields Occoneechee Neck, along Roanoke River; 1971-1975 (Norfolk-Ruston and Appling-Cecil sandy loams). 3 to 5 mi. (4.8 to 8.1 km) n of Rich Square; no date (Lenior-Coxville silt loams).

Clearing of forests for agricultural purposes has increased the amount of habitat suitable for groundhogs in the Piedmont Plateau and Coastal Plain provinces of the Southeast. Highway and utility rights-of-way and river levees appear to have provided paths of dispersal from other upland areas. The success of *Marmota* in this region may in part be a result of a prolonged growing season combined with a limited period of groundhog dormancy. In North Carolina we have reports of active groundhogs from all months of the year.

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Additional Records of Albinistic Amphibians and Reptiles from North Carolina

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ABSTRACT.—Albinism has been reported previously in 6 species of reptiles from North Carolina: *Cemophora coccinea, Crotalus horridus, Elaphe guttata, E. obsoleta, Farancia abacura,* and *Sceloporus undulatus.* This paper describes 16 additional albinistic specimens of 12 amphibian and reptile species from the state. Species represented include the salamanders *Ambystoma talpoideum, Amphiuma means, Eurycea bislineata,* and *Siren intermedia;* the toad *Bufo woodhousei;* the turtle *Chelydra serpentina;* and the snakes *Carphophis amoenus, Diadophis punctatus, E. obsoleta, Nerodia fasciata, N. taxispilota,* and *Virginia striatula.* A description of a snake (*F. abacura*), previously reported but not described, also is included.

INTRODUCTION

Albinism is well known in amphibians and reptiles and records of its occurrence are prevalent in the literature. However, this phenomenon in North Carolina has been reported only in the lizard *Sceloporus undulatus* (Hensley 1968) and the snakes *Cemophora coccinea* (Brimley 1944), *Elaphe obsoleta* (Meacham 1946), and *E. guttata, Farancia abacura* and *Crotalus horridus* (Hensley 1959).

This paper records from the state an additional 16 albinistic specimens of 12 species: 5 salamanders of 4 species, 1 toad, 1 turtle, and 9 snakes of 6 species. A description of an albinistic mud snake, *F. abacura,* recorded but not described by Hensley (1959), also is included.

MATERIALS AND METHODS

Color descriptions of a few individuals were made with the aid of color swatches, and capitalized color names with swatch numbers in parentheses are from Smithe (1975). SVL and TL indicate snout-vent length and total length, respectively. Common and scientific names follow those recommended by Collins et al. (1978). Specimens in the collection of the North Carolina State Museum of Natural History are designated by the acronym NCSM and the catalog number. All specimens were examined alive unless specified otherwise, and those for which no disposition is given are no longer extant.

ANNOTATED LIST

AMPHIBIA

Amphiuma means, Two-toed Amphiuma

NEW HANOVER CO.: near Seabreeze, March or April 1968. An

amphiuma about 230 mm TL was collected from a shallow roadside ditch and described by George Tregembo (pers. comm.). It was white with red eyes and scattered small, pinkish spots.

Siren intermedia intermedia, Eastern Lesser Siren

BRUNSWICK CO.: near Sunny Point, 23 April 1977. A specimen about 200 mm TL was collected with several individuals of the normal phenotype from a borrow pit pond in sandy flatwoods. Its dorsum and limbs were yellow, slightly brighter than Straw Yellow (56), and its venter was paler but near that color. Its gills were rust colored, between Cinnamon-Rufous (40) and Ferruginous (41), and its eyes were red.

Ambystoma talpoideum, Mole Salamander

MACON CO.: 22.5 km (14 mi.) wsw of Franklin, 13 December 1975, NCSM 15961 (21 larvae), 17872 (adult male). Two individuals among a series of 22 larvae collected from a floodplain pond were largely amelanistic in having the characteristic dark brown and black larval patterns replaced by pale gray and gray. One (37.0 mm SVL, 70.9 mm TL) was preserved with the typical specimens shortly after capture. The other, reared in the laboratory, was examined and preserved on 29 May 1977 as an adult (58.0 mm SVL, 100 mm TL). It was pale gray and translucent with many blood vessels and some internal organs visible through the skin. The parotid area and the dorsum of the tail were whitish due to clustered poison glands. The eyes were gray with dark pupils.

Eurycea bislineata cirrigera, Southern Two-lined Salamander

NEW HANOVER CO.: 5.6 km (3.5 mi.) n of Carolina Beach, March 1971, NCSM 10072. A female (40.0 mm SVL, 91.0 mm TL), collected with several individuals of the normal phenotype under leaves in a moist ditch, had a pinkish dorsum and venter with a network of underlying blood vessels visible through the skin. The sides of the head and upper tail had faint brown lines, and the middorsum of the tail was pale yellow. The eyes were brassy with dark pupils.

Bufo woodhousei fowleri, Fowler's Toad

WAKE CO.: Raleigh, June 1965, NCSM 3884. This specimen (34.5 mm SVL) had translucent pinkish skin and dark blue eyes with reddish pupils. Color transparencies from life are in NCSM.

Reptilia

Chelydra serpentina serpentina, Common Snapping Turtle

DAVIE CO.: 12 August 1978. *The Taylorsville Times,* 17 August 1978, contained a very clear photograph of a 16-pound albino caught in a farm pond by Jerry Petrea. From color photographs provided by Jerry and Riley Petrea, the carapace was pale yellowish brown with dark brown sutures. The head, limbs, and tail were slightly paler with scattered brown markings, and the eyes were yellowish with light green pupils.

Nerodia fasciata fasciata, Banded Water Snake

SAMPSON CO.: Laurel Lake, 4.8 km (3 mi.) e of Salemburg, September 1958. Two neonates, among a litter of 9 produced by a female of the normal phenotype, had red pupils and tongues and a white dorsal groundcolor with faint pink crossbands. The other siblings had typical patterns.

Nerodia taxispilota, Brown Water Snake

BLADEN-PENDER CO.: county line, along Black River, May 1961, American Museum of Natural History (112347). An adult male had a pale yellowish dorsum with fine light brown stippling and without traces of blotches. The venter was whitish with pale brown markings, and the eyes were dark.

Virginia striatula, Rough Earth Snake

WAKE CO.: Cary, 4 April 1978, NCSM 20448. A female (about 200 mm TL), found under debris with several specimens of the normal phenotype, had red pupils and a pink tongue. The parietal band was pale yellow and faint. The remainder of the dorsum was pinkish tan, near Salmon (6). The venter was light gray, near Smoke Gray (44). Color transparencies from life are in NCSM.

Diadophis punctatus ssp., Ringneck Snake

DAVIDSON CO.: 11.3 km (7 mi.) s of Denton, May 1979, NCSM 20077. This female (348 mm SVL, 443 mm TL) had a pale olive brown dorsum, a light yellow neck ring bordered by brown, white labials and chin, and reddish brown eyes with dark pupils. The anterior venter was pale yellow, grading to orange yellow posteriorly, and the midventral spots were grayish brown. The snake, although not albinistic to the degree shown in most species here described, was nonetheless conspicuously paler than typical specimens from the state and we consider it an amelanistic variant. Color transparencies from life are in NCSM.

Carphophis amoenus amoenus, Eastern Worm Snake

ROWAN CO.: 4.8 km (3 mi.) nw of Salisbury, 11 April 1979, NCSM 20454. A female about 240 mm TL, collected in a suburban yard and described by R. B. Julian (pers. comm.), was uniformly whitish with a dark pink tongue and reddish eyes.

Farancia abacura abacura, Eastern Mud Snake

HERTFORD CO.: Wiccacon River swamp, near confluence with Chowan River, 5.6 km (3.5 mi.) ne of Harrellsville, 17 July 1947, NCSM 3193. Hensley (1959) reported this adult on the basis of information received from the late Harry T. Davis, former director of NCSM, who apparently neglected to include its description. Color transparencies made of the living snake show that the dorsum was uniformly pinkish. Eye color cannot be ascertained from the photographs, but it appears to have been dark. Mounted and exhibited for more than 30 years, this

snake has now faded to a pale yellow with reddish brown mottling on the head.

Elaphe obsoleta obsoleta, Black Rat Snake

GASTON CO.: 5.6 km (3.5 mi.) sw of Gastonia, summer 1977, Schiele Museum at Gastonia. A captive adult female examined by us on 2 December 1979 had a red tongue, red pupils, and a pinkish white dorsal groundcolor with 35 rather prominent reddish body blotches. Color transparencies from life are in NCSM.

HARNETT CO.: 2.4 km (1.5 mi.) w of Angier, 24 April 1978, NCSM 20043. An adult female, found among the rafters of an old barn, had bright red pupils and a red tongue. The dorsum was white with pink or pale red pigment forming 34 faint middorsal body blotches, a series of alternating lateral blotches weaker than those of the dorsum, and 11 or 12 obscure tail bands. Pattern was most evident on the anterior body. The venter was yellowish white and nacreous, with faint pink mottling along the edges. Color transparencies from life are in NCSM.

NORTHAMPTON CO.: 6.4 km (4 mi.) nw of Rich Square, 3 June 1970, NCSM 9428. An adult male, examined shortly after it was killed by a logging crew, had a plain whitish groundcolor with scarcely discernible pinkish middorsal body blotches. Eye color was not determined.

Two reports of albinistic black rat snakes from Stanly County (Meacham 1946, Hensley 1959) were based on the same specimen, originally in NCSM but now lost.

ACKNOWLEDGMENTS.—We are grateful to the following persons who collected and donated specimens or otherwise provided information: Victor Ambellas, Larry D. Dunnagan, Carl Hiatt, Darrel Jones, Robert B. Julian, Brian Keho, Warren Kimsey, John E. Kiser, Dan F. Lockwood, Pat Mitchell, Jerry and Riley Petrea, Martin O. Shackleford, Richard Stout, George and Robert Tregembo, and Dick and Rick Wells.

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A Distributional Checklist of the Fishes of Kentucky

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ABSTRACT.—A compilation of records of fishes from Kentucky waters based on specimens deposited in museums, personal collecting, and accepted literature reports revealed that 229 species occur or did occur in the state. A substantial amount of new distributional data is presented in the form of an annotated list including records of several species of fishes previously unreported from the state. Distributional statements in the checklist are based on individual spot maps completed for all Kentucky fishes. A list of five problematical species is included at the end of the checklist.

INTRODUCTION

The fish fauna of Kentucky is more diverse than that of any other inland area of comparable size in North America except Tennessee and Alabama. Presently, 229 species are known to occur or to have occurred in Kentucky waters and only 10 or 11 are the result of introduction by man. A major factor contributing to the present completeness of our knowledge of the Kentucky fish fauna has been its rich history of ichthyological investigations going back to the time of one of North America's earliest ichthyologists, Constantine Samuel Rafinesque. Since Rafinesque's groundbreaking work on Ohio River valley fishes (1820) there have been four other reports on Kentucky fishes (Woolman 1892, Garman 1894, Evermann 1918, Clay 1975). Woolman's study is of immense historical value in documenting the distribution of many Kentucky fishes before most of the changes brought on by man took place. Garman's and Evermann's reports are mostly compilations containing little original information. The most recent work on Kentucky fishes (Clay 1975) did not include adequate distributional information and excluded nearly 30 species of fishes that now occur in Kentucky. Moreover, much of Clay's distributional information is in need of revision. This is in part due to the descriptions of new species, the resurrection of others from synonymy, recent intensive collecting in poorly worked areas, and examination of museum records of Kentucky fishes in many institutions throughout the eastern United States that apparently were not consulted by Clay.

A new *Fishes of Kentucky,* aimed at summarizing the distribution

and biology of Kentucky fishes, is in preparation, but its appearance must await additional collecting and a critical compilation of Kentucky fish records from a few other institutions.

MATERIALS AND METHODS

Sources of Data

I completed individual spot distributional maps for each species known to occur or to have occurred in Kentucky waters. The distributional statements are based on those maps. During a final check of all records, those that seemed unreasonable and were not substantiated by specimens were discarded.

The maps and resulting list are based on recent personal collecting, various regional surveys conducted by Kentucky Fish and Wildlife Resources Agency personnel, unquestioned literature records, and specimens that I examined in the following collections: California Academy of Sciences (CAS); Cornell University (CU); Eastern Kentucky University (EKU); Field Museum of Natural History (FMNH); Florida State University (FSU); Illinois Natural History Survey (INHS); Kentucky Fish and Wildlife Resources Agency (KFW); Kentucky Nature Preserves Commission (KNP); University of Kansas (KU); Harvard Museum of Comparative Zoology (MCZ); Murray State University (MSU); Northeast Louisiana University (NLU); Ohio State University (OSU); Southern Illinois University at Carbondale (SIUC); Tulane University (TU); University of Louisville (UL); University of Michigan Museum of Zoology (UMMZ); National Museum of Natural History (USNM); University of Tennessee at Knoxville (UT); University of Tulsa (UTULSAC); and Western Kentucky University (WKU).

In order to show the areas of Kentucky that have been adequately sampled and those that need special attention, the locations of approximately 1150 stations sampled mostly since 1950 were plotted (Fig. 3). Despite the number of sites sampled in the Licking River, it is an area particularly worthy of further collecting efforts (many of the existing records are of only game fishes), as are the upper Cumberland and Big Sandy rivers.

Treatment in the Annotated List

The 229 species of lampreys and fishes known to occur or having occurred naturally or by way of repeated introduction in Kentucky waters are grouped under family names and arranged in phylogenetic sequence following, in part, Greenwood et al. (1966) and Bailey et al. (1970). Within each family, genera and species are listed in alphabetical order. Common and scientific names follow Bailey et al. (1970). In an effort to make the list complete, I included several species that are not taxonomically described but are known to occur in Kentucky. Most of them

have been recognized for more than 20 years and their distributions are accurately known.

I have not departed from the 1970 list of names even though recent studies (some unpublished) reveal that the names of some Kentucky fishes are affected. *Fundulus notti* will probably be accepted for *F. dispar* (Wiley 1977); *Menidia audens* will probably be changed to *M. beryllina.* Although several studies indicate that *Notropis chrysocephalus* intergrades or hybridizes extensively with *N. cornutus* in various parts of its range, I have followed Gilbert (1961) in using the name *N. chrysocephalus* for the Kentucky populations. The Kentucky population hitherto known as *Percina uranidea* should now be called *P. ouachitae* (Williams and Etnier 1977).

I divided Kentucky into 11 subunits, which correspond to river systems, or fish faunal blocks (Fig. 1). For each species, letters denoting the Kentucky subunits in which it is known to occur follow directly after the common name, which is followed by a concise statement regarding the species' current or former distribution in the state. For species restricted to the large bordering Ohio and Mississippi rivers, designation of subunits is not applicable. My use of the terms "generally distributed," "occasional," or "sporadic" follow the definitions of Smith (1965).

Distribution is sometimes expressed in terms of sections of the state, such as eastern two-thirds or western half. In many instances, it is expressed in terms of specific drainage systems or waters such as Mississippi River, lower Ohio River, and Big Sandy River drainage. For species known in Kentucky from only one or a few records, the name of the stream or major drainage basin and the county involved usually are given, as well as the acronym of the museum or university that contains specimens. The counties of Kentucky are depicted in Figure 2. In a few cases I cited recent references to uncommon species, especially if the papers pointed out more detailed information on their Kentucky ranges.

A list of a few problematical species is included in this report. The annotations for these species, all hypothetical in the Kentucky fauna, are self-explanatory. Also included in the problematical list are species that were included in earlier lists of Kentucky fishes, but with the present state of our knowledge can now be deleted from the Kentucky list.

ANNOTATED LIST OF SPECIES

The 229 species in the following list represent 69 genera and 27 families. Twelve species (*Alosa alabamae, Clinostomus elongatus, Hemitremia flammea, Hybopsis x-punctata, Notropis amnis, Lagochila lacera, Lota lota, Ammocrypta asprella, A. clara, A. vivax, Etheostoma microperca, Percina burtoni*) have not been recently encountered and their current status in Kentucky is discussed.

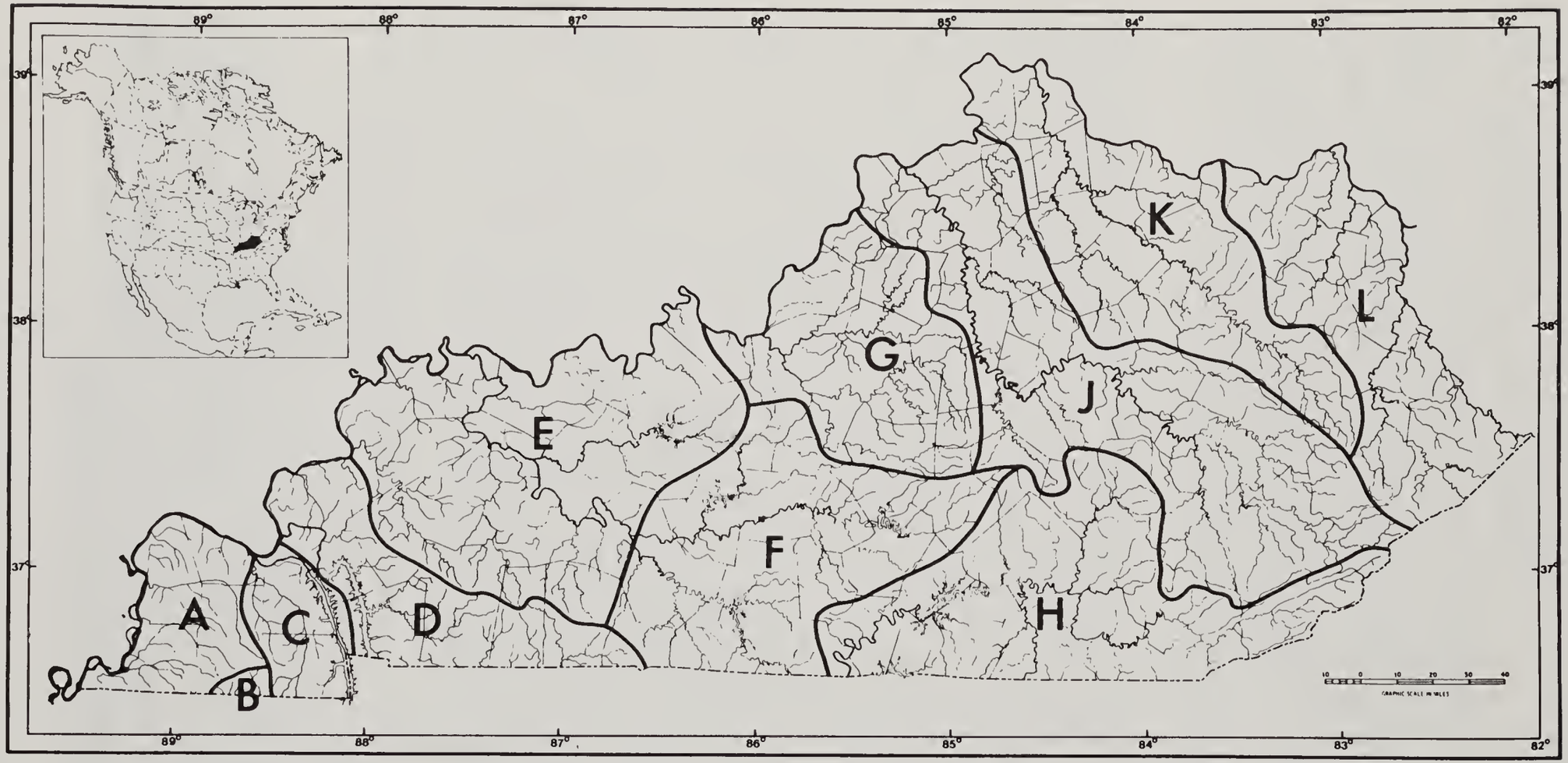

Fig. 1. Divisions of major drainages and/or ichthyofaunal blocks as they relate to fish distribution patterns. A, lower Ohio River tributaries, Mayfield and Obion creeks and Bayou du Chien. B, Terrapin Creek and other small tributaries of Obion River. C, lower Tennessee and Clarks rivers. D, lower Cumberland River. E, Tradewater and lower Green rivers. F, upper Green and Barren rivers. G, Salt River. H, upper Cumberland River. J, Kentucky River. K, Licking River. L, Tygart's Creek, Little Sandy and Big Sandy rivers.

Petromyzontidae — lampreys

Icthyomyzon bdellium (Jordan). Ohio lamprey. D,E,F,G,H,J,K,L. Occasional in the Green, Cumberland, Kentucky, Licking and Ohio rivers. The specific distinctiveness of this form deserves further study. Hubbs and Trautman (1937:14) resurrected the name *bdellium* and suggested that the two "geographic forms" (*bdellium* and *castaneus*) may intergrade in the lower Ohio River. Starrett et al. (1960) identified only *I. castaneus* in the Wabash River, Illinois, where Hubbs and Trautman had earlier identified specimens as *I. bdellium.* The characteristics of the two forms overlap greatly and specimens cannot be assigned with confidence to the form *bdellium;* consequently, parasitic lampreys from the middle and upper Ohio River and its major tributaries are identified arbitrarily as *bdellium* on the basis of geography.

Ichthyomyzon castaneus Girard. Chestnut lamprey. C,D. Occasional in the lower Ohio, Mississippi, Cumberland and Tennessee rivers. See comments under *I. bdellium.*

Ichthyomyzon fossor Reighard and Cummins. Northern brook lamprey. J,L. Rare in the upper parts of the Kentucky (EKU, UMMZ, KNP), Big Sandy (UL) and Little Sandy River (KNP) systems.

Ichthyomyzon gagei Hubbs and Trautman. Southern brook lamprey. C. A record based on one specimen from Clarks River, Calloway County (SIUC).

Ichthyomyzon greeleyi Hubbs and Trautman. Allegheny brook lamprey. F,H,J. Rare and sporadic in the upper Green (USNM), Cumberland (REJ) and Kentucky (KFW, UL) drainages. Hoyt's (1979) record of this species from the Ohio River at Paducah is not considered valid, and was probably based on misidentified *I. castaneus.*

Ichthyomyzon unicuspis Hubbs and Trautman. Silver lamprey. C,E,F,H,J. Occasional in large rivers or their major tributaries throughout the state.

Lampetra aepyptera (Abbott). Least brook lamprey. B,C,D,E,F, G,H,J,K,L. The most common lamprey in Kentucky, occurring in small to medium-size streams throughout the state except in the extreme west.

Lampetra lamottei (Lesueur). American brook lamprey. F,J,L. Occasional in the upper reaches of the Barren, Green, Kentucky and Big Sandy drainages.

Acipenseridae — sturgeons

Acipenser fulvescens Rafinesque. Lake sturgeon. C,D,H. Formerly present in the main channels of the Ohio, Mississippi, Tennessee and Cumberland rivers (Call 1896, Woolman 1892, Evermann 1902). Most recent specimen from Cumberland River, McCreary County (UL). Status in Ohio and Mississippi rivers uncertain although several commercial fishermen told me that lake sturgeons are caught during early spring

in the Mississippi River.

Scaphirhynchus albus (Forbes and Richardson). Pallid sturgeon. Rare in the main channel of the Mississippi River where it is captured by commercial fishermen. No definite records, but descriptions of specimens by fishermen apply to this species. It has been taken farther south in the Mississippi River (Bailey and Cross 1954), so is clearly part of the Kentucky fauna.

Scaphirhynchus platorynchus (Rafinesque). Shovelnose sturgeon. Occasional in the main channels of the Ohio and Mississippi rivers.

Polyodontidae — paddlefishes

Polyodon spathula (Walbaum). Paddlefish. A,C,D,H,J,K. Occasional in the Mississippi, Ohio, Cumberland, Tennessee, Kentucky and Licking rivers. Not reported from the Licking River since Barbour (1951).

Lepisosteidae — gars

Lepisosteus oculatus (Winchell). Spotted gar. A,D. Rare in the Mississippi (SIUC), lower Ohio and Cumberland rivers (UL). Has not been taken farther east in the Ohio River than near the mouth of the Tradewater River.

Lepisosteus osseus (Linnaeus). Longnose gar. C,D,E,F,G,H,J,K,L. The most common and widespread gar in Kentucky, occurring in large rivers (and lakes) and their major tributaries throughout the state.

Lepisosteus platostomus Rafinesque. Shortnose gar. A,C,D. Limited to the western one-fourth of Kentucky where it is most common in Bayou du Chien, Obion Creek and Land Between the Lakes. Occasional to common in the lower Ohio and Mississippi rivers.

Lepisosteus spatula Lacépède. Alligator gar. A,D. Four valid records presently are known, one each from the Tennessee River (Barbour 1963), mouth of the Ohio River (picture at INHS), Ohio River at Paducah (Hoyt 1979), and mouth of Bayou du Chien (EKU). Trautman (1957) reported other records (mostly anecdotal) of the species from the Ohio River as far east as Bracken County. Status uncertain, although Hoyt (1979) reported capture of 20 individuals during a two year study of fish impingement at the Shawnee Steam Plant, Paducah.

Amiidae — bowfins

Amia calva Linnaeus. Bowfin. A,C,D,E,G,J,L. Sporadic on the Coastal Plain (INHS, MSU, SIUC, UL) and in backwater areas of the Green (SIUC, KNP), Salt (UL) and Kentucky rivers (KFW). Branson (1977) reported specimens from Tygart's Creek, Carter County (EKU).

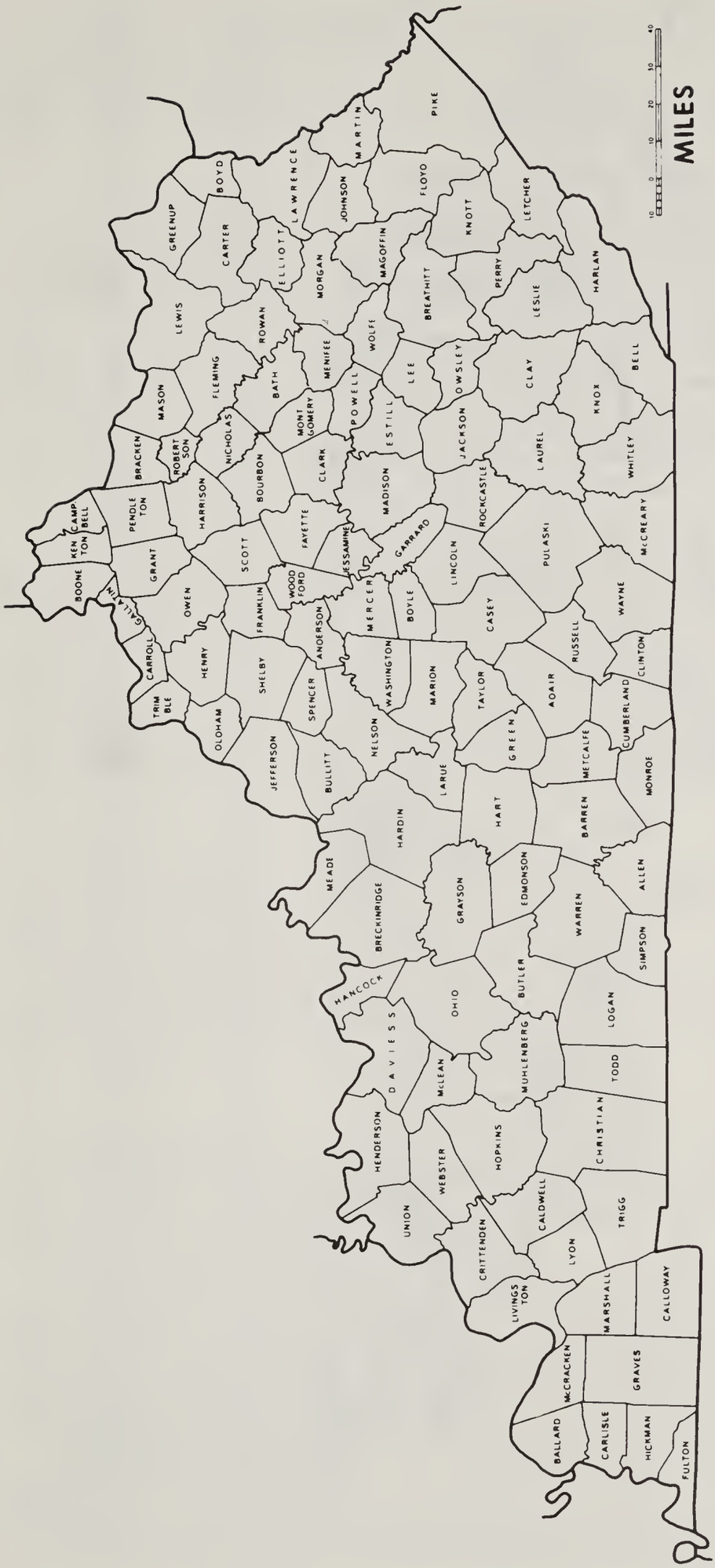

Fig. 2. The counties of Kentucky.

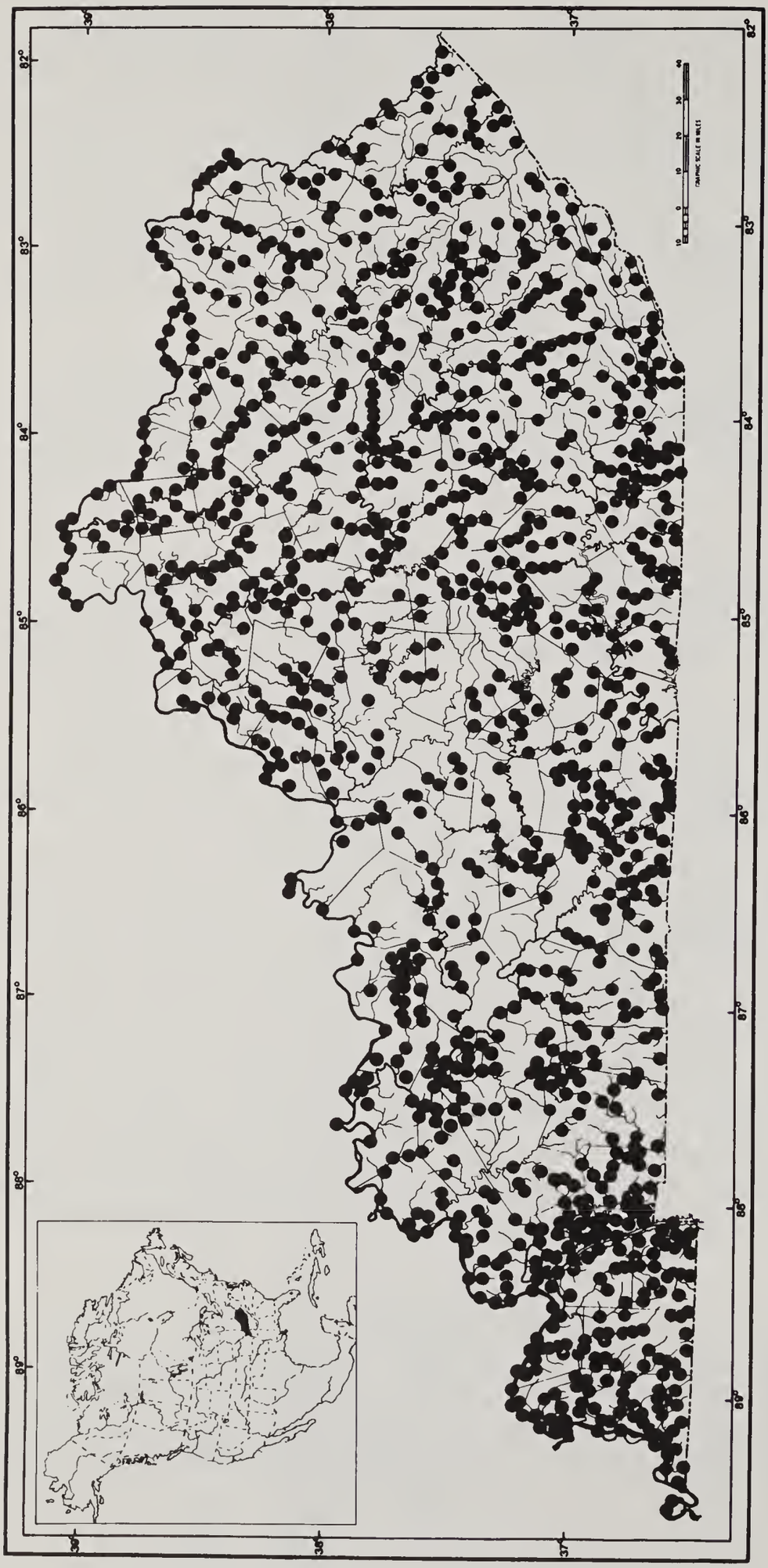

Fig. 3. Locations of fish collections made in Kentucky, mostly between 1950 and the present. Each dot represents two or more species from a site.

Anguillidae — freshwater eels

Anguilla rostrata (Lesueur). American eel. C,D,E,G,H,J,K,L. Catadromous. Sporadic in large rivers throughout the state, although I know of no valid records from the upper Green River.

Clupeidae — herrings

Alosa alabamae Jordan and Evermann. Alabama shad. Anadromous. Formerly present in the Mississippi and Ohio rivers. Not reported from Kentucky waters since just before 1900 although Pflieger (1975) and Smith (1979) reported recent records from Missouri and Illinois, respectively. Probably only enters the Kentucky part of the Mississippi River for spawning.

Alosa chrysochloris (Rafinesque). Skipjack herring. C,D,E,G,J. Common in the main channels of the Mississippi and Ohio rivers and the lower reaches of their major tributaries.

Dorosoma cepedianum (Lesueur). Gizzard shad. A,C,D,E,F,G,H, J,K,L. Abundant and generally distributed throughout the state, and especially common in large rivers, lakes and reservoirs.

Dorosoma petenense (Günther). Threadfin shad. C,D,E,F,H,J. Generally distributed in the main channel of the Ohio River from Louisville to its mouth (Minckley and Krumholz 1960), and the main channels of the Mississippi, lower Cumberland, lower Tennessee and lower Green rivers. Introduced into reservoirs throughout the state.

Hiodontidae — mooneyes

Hiodon alosoides (Rafinesque). Goldeye. A,C,D,E,F,H,J. Occasional to common in the Ohio and Mississippi rivers and in large and medium-size rivers throughout the state.

Hiodon tergisus Lesueur. Mooneye. C,D,E,F,G,H,J,K. Sporadic in the Ohio and Mississippi rivers. Occasional in large and medium-size rivers throughout the state, except the Big Sandy drainage.

Salmonidae — trouts

Salmo gairdneri Richardson. Rainbow trout. D,F,G,H,J,K,L. Introduced. Sporadic in the reservoirs and streams where it has been introduced. Most stocking, with marginal success, has taken place in Lake Cumberland (Axon 1974).

Salmo trutta Linnaeus. Brown trout. F,J. Introduced. Recently (1977) stocked in Indian Creek (Powell and Menifee counties), Big Double Creek (Clay County) and Trammel Fork (Allen County). However, sampling in those streams by district fishery biologists indicates no survival (Peter W. Pfeiffer, pers. comm.).

Salvelinus fontinalis (Mitchill). Brook trout. H. Introduced. Presently known only from Martin's Fork and Shillalah Creek, Bell County, where it is sporadic in occurrence.

Osmeridae — smelts

Osmerus mordax (Mitchill). Rainbow smelt. Recently captured from the Mississippi River, Carlisle County (SIUC), and now known from several localities along the entire Mississippi River from the mouth of the Missouri River to Louisiana (Burr and Mayden, in press; Royal D. Suttkus, pers. comm.). It was collected only during December and January in 1978 and 1979.

Umbridae — mudminnows

Umbra limi (Kirtland). Central mudminnow. A,B,C. A rare species recently captured from Terrapin Creek, Graves County (SIUC), and Clarks River, Marshall County (SIUC). Reported by Sisk (1973) from southwestern Fulton County (MSU).

Esocidae — pikes

Esox americanus Lesueur. Grass pickerel. A,B,C,D,E,F,G,H,J,K,L. Common throughout the western half of the state and occasional in the eastern half.

Esox lucius Linnaeus. Northern pike. C,J,L. Introduced. Rare and infrequently reported from the reservoirs where it has been planted. Status uncertain and perhaps should not be considered a part of the state ichthyofauna.

Esox masquinongy Mitchill. Muskellunge. F,J,K,L. Rare and sporadic in the Green, Kentucky, and Licking River drainages and Tygarts Creek. Most populations probably are presently maintained by stocking.

Esox niger Lesueur. Chain pickerel. A,C. Very rare in oxbow lakes along the lower Ohio (INHS) and Mississippi (SIUC) rivers. Reported from Clarks River, Calloway County, by Sisk (1969) but specimens apparently are no longer extant. Recent specimens were discussed by Burr and Mayden (1979).

Cyprinidae — minnows and carps

Campostoma anomalum (Rafinesque). Stoneroller. A,C,D,E,F,G,H, J,K,L. Abundant throughout the state, being noticeably absent from Bayou du Chien, Obion Creek, and region B.

Carassius auratus (Linnaeus). Goldfish. A,C,D,E,F,G,J,K. Introduced. Sporadic in large to medium-size rivers and reservoirs throughout most of the state. Confirmed records from the Big Sandy drainage are unavailable.

Clinostomus elongatus (Kirtland). Redside dace. K. Reported in a manuscript list of the fishes of northeastern Kentucky (Clark 1940) from Lick Fork of upper North Fork, Licking River, Rowan County. I have been unable to locate the specimen(s) on which this record is based and no one has since reported the species in Kentucky. The record could

possibly be based on a misidentification, or the species may be very rare or extirpated here.

Clinostomus funduloides Girard. Rosyside dace. C,D,F,K,L. Sporadic in small tributaries of the lower Tennessee (Burr and Mayden 1979, Miller 1978) and Cumberland rivers (Burr and Mayden 1979) and several streams in region L (KFW, UL). More recently discovered in the upper Barren River system, Barren County (TU), the upper Green river system, Casey County (TU), and the Little Licking River (Branson 1977).

Ctenopharyngodon idella (Valenciennes). Grass carp. Introduced. Presently known only from the main channel of the Mississippi River where it is generally taken only by commercial fishermen (Pflieger 1978).

Cyprinus carpio Linnaeus. Carp. A,C,D,E,F,G,H,J,K,L. Introduced. Distributed throughout the state.

Ericymba buccata Cope. Silverjaw minnow. E,G,H,J,K,L. Common from the lower Tradewater River system (Burr et al. 1980) eastward to and including the Big Sandy River drainage.

Hemitremia flammea (Jordan and Gilbert). Flame chub. H. Reported to be abundant in Big Laurel River, Laurel County (Jordan and Brayton 1878) and also collected from Clear Fork and Wolf Creek near Pleasant View, Whitley County (Jordan and Swain 1883). There are no reports of this species in Kentucky waters since Jordan's work, and it is probably extirpated.

Hybognathus hayi Jordan. Cypress minnow. A. Occasional in Bayou du Chien, (MSU, SIUC), Obion Creek (MSU), Mayfield Creek (INHS, SIUC) and oxbow lakes of the Ohio River (INHS). Considered to be more common than formerly thought (Burr et al. 1980).

Hybognathus nuchalis Agassiz. Silvery minnow. A,B,C,D,E,F. Common in the main channel of the Ohio River from its mouth northeast to Louisville. Abundant in the lower Green River drainage and other medium-size streams, rivers and sloughs in the western half of the state. A record from the Rockcastle River drainage, Rockcastle County (Branson and Batch 1972) needs substantiation. Formerly known from the Big Sandy River (Woolman 1892).

Hybognathus placitus Girard. Plains minnow. Known only from one locality, near the mouth of the Ohio River (Pflieger 1975, Smith 1979). Attempts to collect this species farther south in the Kentucky part of the Mississippi River have been unsuccessful.

Hybopsis aestivalis (Girard). Speckled chub. F,H,J,K,L. Rare in the main channel of the Ohio and Mississippi rivers. Occasional in the upper Green, Barren, Cumberland, Kentucky, Licking and Big Sandy River systems.

Hybopsis amblops (Rafinesque). Bigeye chub. D,E,F,G,H,J,K,L. Occasional in clear streams throughout the eastern two-thirds of the state. Apparently does not occur above the falls of the Cumberland River.

Hybopsis dissimilis (Kirtland). Streamline chub. D,F,G,H,J,L. Occasional in the high gradient parts of the Cumberland, Green, Barren, Rolling Fork, Kentucky and Big Sandy River systems. I am unaware of confirmed records from the Licking River drainage although the species probably occurs there.

Hybopsis gelida (Girard). Sturgeon chub. Presently known from one locality, near the mouth of the Ohio River (Pflieger 1975). Numerous attempts to collect this species farther south in the Kentucky part of the Mississippi River have been unsuccessful. It is clearly part of the Kentucky fauna since it also occurs as far south in the Mississippi River as Mississippi.

Hybopsis gracilis (Richardson). Flathead chub. Known from only two localities, both in the main channel of the Mississippi River, where it is uncommon.

Hybopsis insignis Hubbs and Crowe. Blotched chub. C,H. Unknown from region C since its original description by Hubbs and Crowe (1956) and the subsequent impoundment of the lower Tennessee River. Rare in the upper Cumberland River where it has been taken at four localities.

Hybopsis meeki Jordan and Evermann. Sicklefin chub. Presently known from only one locality, at the confluence of the Ohio River with the Mississippi River (Pflieger 1975, Smith 1979). It has been taken farther south in the Mississippi River (Bailey and Allum 1962), so is clearly part of the Kentucky fauna.

Hybopsis storeriana (Kirtland). Silver chub. C,D,E,F,G,H,J,K,L. Generally distributed in large and medium-size rivers throughout the state, including the main channels of the Ohio and Mississippi rivers where it is the most common *Hybopsis*.

Hybopsis x-punctata Hubbs and Crowe. Gravel chub. Known from only three localities in the Ohio River in Campbell, Greenup and Boyd counties (Trautman 1957); needs substantiation.

Nocomis biguttatus (Kirtland). Hornyhead chub. J. Known from three localities in Franklin County (UMMZ, UL, CU). Lachner and Jenkins (1971) suspected that the isolated Kentucky River population of this species was perhaps the result of a bait or stocking introduction.

Nocomis effusus Lachner and Jenkins. Redtail chub. D,F,H. Occasional in the Cumberland River between Cumberland Falls and the Little River system. Rare in the upper Green River drainage where it is known from two localities. Extensive collecting in the lower Green River has not revealed the presence of this species, despite the suggestion by Lachner and Jenkins (1967) that it might occur there.

Nocomis micropogon (Cope). River chub. H,J,K,L. Common in the upper Cumberland, upper Kentucky and Licking River systems. Occasional in region L.

Notemigonus crysoleucas (Mitchill). Golden shiner. A,B,C,D,E, F,G,H,J. Generally distributed in the western two-thirds of the state. A

record from the Cumberland River above the falls is presumably based on an introduction.

Notropis amnis Hubbs and Greene. Pallid shiner. C,F,H. Until recently the only published record of this species was from Clarks River, Marshall County (Hubbs 1951). Other records are available from Jennings's Creek, Warren County (SIUC), Otter Creek, Wayne County (CU), and Green River, Hart County (UMMZ). A very rare species which is probably nearing extinction in Kentucky.

Notropis ardens (Cope). Rosefin shiner. C,D,E,F,G,H,J,K,L. Generally distributed from the lower Tennessee River system eastward, avoiding lowland areas in region E. Apparently not present in the Big Sandy drainage.

Notropis ariommus (Cope). Popeye shiner. F,G,H,J. Uncommon in the upper Green, Barren, Rolling Fork, Cumberland and Kentucky River drainages. No records are available from above Cumberland Falls.

Notropis atherinoides Rafinesque. Emerald shiner. A,C,D,E,F,G, H,J,K,L. Generally distributed throughout the state.

Notropis blennius (Girard). River shiner. C,D. Common in the main channels of the Mississippi and Ohio rivers. Rare in the lower Tennessee and Cumberland rivers since their impoundment.

Notropis boops Gilbert. Bigeye shiner. C,D,E,F,G,H,J,K,L. Somewhat sporadic in the western two-thirds of Kentucky where it occurs in the Clarks, upper Pond, upper Barren, upper Green and upper Cumberland (below the falls) River systems. More evenly distributed in the Salt, lower Kentucky and lower Licking rivers and in the northern portion of region L.

Notropis buchanani Meek. Ghost shiner. D,E,F,G,H,J,K. Occasional in large rivers (including the Ohio River) and their major tributaries throughout Kentucky, except in the extreme western counties and the Big Sandy drainage. Probably most common in the lower Green River.

Notropis camurus (Jordan and Meek). Bluntface shiner. A,B. Known only from Terrapin Creek, Graves County (SIUC), where it is common, and Obion Creek, Hickman County (FSU), where it is rare.

Notropis chrysocephalus (Rafinesque). Striped shiner. C,D,E,F,G, H,J,K,L. Generally distributed throughout the state avoiding the Coastal Plain and parts of the lower Green River drainage.

Notropis emiliae (Hay). Pugnose minnow. A,C,D,E,F. Sporadic throughout the western half of the state.

Notropis fumeus Evermann. Ribbon shiner. A,B,C,D,E. Abundant throughout the western third of the state (Burr et al. 1980).

Notropis galacturus (Cope). Whitetail shiner. D,H,L. Known in Kentucky only from the Cumberland and Big Sandy River drainages. A population exists in Red River, Todd and Logan counties, and the species is evenly distributed in the upper Cumberland River below the

falls. Uncommon in the Big Sandy drainage where it is known only from Pike County (KNP).

Notropis hudsonius (Clinton). Spottail shiner. Known only from a single locality near the confluence of the Ohio and Mississippi rivers (Pflieger 1975).

Notropis leuciodus (Cope). Tennessee shiner. F,H. Occasional to common in the upper Barren, Green and Cumberland River drainages.

Notropis lutrensis (Baird and Girard). Red shiner. A,E. Common in Bayou du Chien, Obion Creek, and small tributaries to the lower Ohio River. A small population is present in the lower Tradewater River (Burr et al. 1980). Occasional in the main channels of the Mississippi and lower Ohio rivers.

Notropis maculatus (Hay). Taillight shiner. A. Occasional to common in the oxbow lakes and ponds of the lower Ohio and Mississippi rivers (Burr and Page 1975).

Notropis photogenis (Cope). Silver shiner. E,F,G,H,J,K,L. Generally distributed throughout the eastern half of the state.

Notropis rubellus (Agassiz). Rosyface shiner. F,G,H,J,K,L. Generally distributed throughout the eastern half of the state.

Notropis shumardi (Girard). Silverband shiner. D. Occasional to common in the main channels of the lower Ohio (Union County westward) and Mississippi rivers. A record from the lower Cumberland River is based on a preimpoundment study and I doubt that the species is still present there.

Notropis spilopterus (Cope). Spotfin shiner. A,C,D,E,F,G,H,J,K,L. Generally distributed throughout the state, but sporadic on the Coastal Plain.

Notropis stramineus (Cope). Sand shiner. A,G,J,K,L. Occasional to common from Doe Run, Meade County, and eastward. Disjunct in Mayfield Creek, Carlisle and Graves counties (Burr et al. 1980). Hoyt's (1979) record for this species from the Green River at Paradise was based on *N. volucellus*.

Notropis telescopus (Cope). Telescope shiner. H. Known only from region H of the Cumberland River below the falls.

Notropis umbratilis (Girard). Redfin shiner. A,B,C,D,E,G,J,K,L. Common in the Coastal Plain. Generally distributed along the northern border of the state from the lower Cumberland River to region L.

Notropis venustus (Girard). Blacktail shiner. A. Known from comparatively few specimens from two localities each in Bayou du Chien (MSU), the Mississippi River (SIUC), and the lower Ohio River (INHS). This species is rare, although apparently suitable habitat is present, in western Kentucky.

Notropis volucellus (Cope). Mimic shiner. A,C,D,E,F,G,H,J,K,L. Sporadic in occurrence but generally distributed throughout the state, usually in large to medium-size rivers.

Notropis whipplei (Girard). Steelcolor shiner. A,C,D,E,F,G,H, J,K,L. Rare in extreme western Kentucky, and occasional to common throughout the rest of the state.

Notropis species. Undescribed. Palezone shiner. H. A species or subspecies of *Notropis* allied to *N. procne* has been identified from the Little South Fork of the Cumberland River, Wayne County (Robert E. Jenkins, pers. comm.).

Notropis species. Undescribed. Sawfin shiner. H. An undescribed species related to *N. spectrunculus* occurs in the Little and Big South Forks of the Cumberland River, Wayne County, and probably also occurs in tributaries of Wolf River in Cumberland and Clinton counties.

Phenacobius mirabilis (Girard). Suckermouth minnow. A,B,C,E, G,H,J,K,L. Common in the Coastal Plain and lowland areas in region E. Occasional to uncommon in the Salt, Kentucky, Licking, upper Cumberland and Big Sandy River systems.

Phenacobius uranops (Cope). Stargazing minnow. F,H. Occasional to common in the upper Barren and Green rivers. Uncommon in the Rockcastle River.

Phoxinus cumberlandensis Starnes and Starnes. Blackside dace. H. A recently described species endemic to the upper Cumberland River (TU, UL, UMMZ, UT) where it is uncommon and considered endangered due to strip mine pollution (Starnes and Starnes 1978). Several additional populations were recently discovered in the Rockcastle and Laurel River drainages (KNP).

Phoxinus erythrogaster (Rafinesque). Southern redbelly dace. C,D,E,F,G,H,J,K,L. A common inhabitant of small, springfed, upper elevation streams throughout the eastern two-thirds of the state. A population on the Coastal Plain was recently discovered (Freeze and Rayburn 1977).

Pimephales notatus (Rafinesque). Bluntnose minnow. A,C,D,E,F, G,H,J,K,L. One of the most abundant and ubiquitous minnows in Kentucky, occurring throughout the state and avoiding only the extreme lowland areas in the west (e.g., Mayfield Creek, Bayou du Chien, Obion Creek).

Pimephales promelas (Rafinesque). Fathead minnow. A,C,E,F,G, H,J,K,L. Sporadic in the Coastal Plain and entire Green River. Occasional to common in the eastern half of Kentucky. Several records may be the result of deliberate introductions.

Pimephales vigilax (Baird and Girard). Bullhead minnow. C,D,E,F,G,H,J,K,L. Generally distributed throughout the state in large to medium-size rivers, probably reaching its greatest abundance in the lower Ohio and Green rivers.

Rhinichthys atratulus (Hermann). Blacknose dace. C,D,F,G,H, J,K,L. Occasional to sporadic throughout most of the state except the extreme western part. Common above Cumberland Falls. The

distribution of this species in Kentucky is spotty, which most likely reflects inadequate sampling of its preferred habitat.

Semotilus atromaculatus (Mitchill). A,B,C,D,E,F,G,H,J,K,L. Abundant and generally distributed in small to medium-size streams throughout the state.

Catostomidae — suckers

Carpiodes carpio (Rafinesque). River carpsucker. A,C,D,E,G,H, J,K,L. Generally distributed in large rivers and the lower reaches of their major tributaries throughout Kentucky.

Carpiodes cyprinus (Lesueur). Quillback. C,D,E,G,H,J,K,L. Generally distributed in large to medium-size rivers in the eastern half of the state and occasional in the western half.

Carpiodes velifer (Rafinesque). Highfin carpsucker. D,H,J,K. Sporadic throughout the eastern half of Kentucky (17 localities), and rare in the western half (3 localities).

Catostomus commersoni (Lacépède). White sucker. A,C,D,E,F, G,H,J,K,L. Common and generally distributed in small and medium-size streams from Massac Creek, McCracken County, and eastward throughout the state.

Cycleptus elongatus (Lesueur). Blue sucker. D,E,K. Rare in the main channel of the Ohio River (10 records within the last 50 years; INHS, UL, OSU). Rare in the lower Green, Kentucky and Licking rivers. Formerly present in the lower Tennessee and Cumberland rivers (Woolman 1892) before impoundment.

Erimyzon oblongus (Mitchill). Creek chubsucker. A,B,C,D,E,F,G. Generally distributed from the lower Salt and Green rivers westward.

Erimyzon sucetta (Lacépède). Lake chubsucker. A,E. One of the rarest species in Kentucky and presently known from only five localities: Obion Creek, Hickman County (KFW, UL, SIUC), Snapneck Creek, Fulton County (SIUC), Long Falls Creek, McLean County (SIUC), Ohio River at Paducah (Hoyt 1979), and Cypress Creek, Muhlenberg County (KNP).

Hypentelium nigricans (Lesueur). Northern hog sucker. C,D,E,F, G,H,J,K,L. Generally distributed from Clarks River to the Big Sandy basin, avoiding lowland areas in region E.

Ictiobus bubalus (Rafinesque). Smallmouth buffalo. A,C,D,E,G, J,K,L. Generally distributed in the lower reaches of large and medium-size rivers and reservoirs throughout the state, including the Ohio and Mississippi rivers proper.

Ictiobus cyprinellus (Valenciennes). Bigmouth buffalo. A,C,D,E, F,G,H,J,K. Occasional in large and medium-size rivers (and reservoirs) throughout Kentucky, excluding the Big Sandy basin. Also present in the main channels of the Ohio and Mississippi rivers.

Ictiobus niger (Rafinesque). Black buffalo. A,D,E. Sporadic in large

rivers and reservoirs throughout the western half of Kentucky. Occasional in the main channels of the Ohio and Mississippi rivers.

Lagochila lacera Jordan and Brayton. Harelip sucker. H,J. Extinct. Formerly known from five localities, one in the Kentucky River system, Jessamine County (MCZ) and four in the upper Cumberland River system (Woolman 1892, Kirsch 1893).

Minytrema melanops (Rafinesque). Spotted sucker. A,C,D,E, F,G,H,J,K,L. Generally distributed throughout the state but rarely taken in large numbers.

Moxostoma anisurum (Rafinesque). Silver redhorse. D,F,H,J,K,L. Sporadic throughout the eastern half of Kentucky. Not taken from region D since impoundment of the Cumberland River.

Moxostoma atripinne Bailey. Blackfin sucker. F. Endemic to the Barren River system where it is known from nine localities, in Allen, Barren and Monroe counties.

Moxostoma carinatum (Cope). River redhorse. D,F,H,J,K,L. Sporadic in large and medium-size rivers throughout the eastern half of the state. Rare in the main channel of the Ohio River.

Moxostoma duquesnei (Lesueur). Black redhorse. D,E,F,G,H,J,K,L. Occasional throughout the eastern four-fifths of Kentucky, from the Little River system to the Big Sandy system.

Moxostoma erythrurum (Rafinesque). Golden redhorse. A,C,D,E, F,G,H,J,K,L. Generally distributed throughout the state, and the most common *Moxostoma* in Kentucky. Uncommon, however, in the Coastal Plain.

Moxostoma macrolepidotum (Lesueur). Shorthead redhorse. A,C, D,F,G,H,J,K,L. Occasional throughout the state, in large and medium-size rivers. Very rare in the Coastal Plain.

Ictaluridae — freshwater catfishes

Ictalurus catus (Linnaeus). White catfish. L. Introduced. The present distribution of this species in Kentucky is difficult to ascertain. It has been widely introduced in private commercial fishing lakes in Kentucky, and planted once in Greenbo Lake, Greenup County (Clay 1975). A single specimen from the Ohio River, Breckenridge County is known (Clay 1975).

Ictalurus furcatus (Lesueur). Blue catfish. A,C,D,E,J,K. Occasional in the Ohio and Mississippi rivers and the lower reaches of their major tributaries.

Ictalurus melas (Rafinesque). Black bullhead. A,B,C,D,E,F,G,H, J,K,L. Generally distributed throughout the state.

Ictalurus natalis (Lesueur). Yellow bullhead. A,B,C,D,E,F,G,H, J,K,L. Generally distributed throughout the state and generally more common than the black bullhead, with which it is often taken.

Ictalurus nebulosus (Lesueur). Brown bullhead. D,E,G,J,K. Sporadic

in large and medium-size rivers from the lower Cumberland to the Licking River.

Ictalurus punctatus (Rafinesque). Channel catfish. A,C,D,E,F,G, H,J,K,L. Generally distributed in sandy-gravelly sections of large and medium-size rivers throughout Kentucky.

Noturus elegans Taylor. Elegant madtom. F,L. Previously known in Kentucky only from the Barren and Green rivers, where it is common in certain localities. Bauer and Branson (1979) reported this species from the Little Sandy River system, Elliott County (EKU).

Noturus eleutherus Jordan. Mountain madtom. F,G,H,J,K,L. Sporadic in the main channel of the Ohio River, occasional in the upper Green, upper Cumberland, Salt, Kentucky, Licking and Big Sandy rivers.

Noturus exilis Nelson. Slender madtom. D,F. Rare in the lower Cumberland (KFW, UL), upper Green (KFW, UL) and Barren (KFW) rivers. One collection from Eagle Creek, Grant County (UL), needs substantiation.

Noturus flavus Rafinesque. Stonecat. D,F,G,H,J,K,L. Common in the eastern half of Kentucky although apparently absent from the Big Sandy basin. Older records are from the Ohio River, Livingston County, (UL) and Little River, Trigg County (KFW).

Noturus gyrinus (Mitchill). Tadpole madtom. A,C,D,E,G,J. Occasional in the Coastal Plain and the lower reaches of streams along the northern border of the state, to the Kentucky River drainage.

Noturus hildebrandi (Bailey and Taylor). Least madtom. B. Known only from Terrapin Creek, Graves County (SIUC) where it is taken most frequently from sandy raceways and brush piles at night (Burr and Mayden 1979).

Noturus miurus Jordan. Brindled madtom. A,C,D,E,F,G,H,J,K,L. Generally distributed throughout the state, including the upper Cumberland River system both above (Starnes and Starnes 1978) and below the falls.

Noturus nocturnus Jordan and Gilbert. Freckled madtom. A,C,D,E,F,J,L. Occasional in the Coastal Plain and the Green River basin. Sporadic throughout the rest of the state with only one record from the upper Kentucky River and two from region L.

Noturus phaeus Taylor. Brown madtom. B. Known only from Terrapin and Powell creeks, Graves County (SIUC), where it is fairly common in riffles with accumulated sticks and debris (Burr and Mayden 1979).

Noturus stigmosus Taylor. Northern madtom. F,G,J,K,L. Sporadic in the eastern half of the state. Two records are from the main channel of the lower Ohio River.

Pylodictis olivaris (Rafinesque). Flathead catfish. A,C,D,E,F,G, H,J,K,L. Generally distributed throughout Kentucky in large and

medium-size rivers and reservoirs. Consistently taken from the Ohio and Mississippi rivers by commercial fishermen.

Amblyopsidae — cavefishes

Amblyopsis spelaea DeKay. Northern cavefish. F,G. Occurs from Mammoth Cave, Edmonson County, north to caves in Breckenridge County and probably occurs in caves between those sites.

Chologaster agassizi Putnam. Spring cavefish. C,D,E,F. From springfed streams near the Ohio River, Livingston County, through Land Between the Lakes and Red River of the Cumberland, to Mammoth Cave, Edmonson County. Recently captured in a small stream in the Pond River drainage, Muhlenberg County (SIUC).

Typhlichthys subterraneus Girard. Southern cavefish. F. Known from several caves in Barren, Edmonson, Hart, Pulaski and Warren counties.

Aphredoderidae — pirate perches

Aphredoderus sayanus (Gilliams). Pirate perch. A,B,C,D,E,G. Generally distributed throughout the western half of the state; two localities in Jefferson County (UL).

Percopsidae — trout-perches

Percopsis omiscomaycus (Walbaum). Trout-perch. F,G,K,L. Sporadic in the middle Licking River and the northern half of region L. Two localities for Jefferson County (UL), one locality in the Green River system, Casey County (KFW), and one locality in the Barren River system, Allen County (Bauer and Branson 1979).

Gadidae — codfishes

Lota lota (Linnaeus). Burbot. J,K. Known from five localities in Kentucky, all reported by Clay (1975). A rare and poorly known species in the state. It is uncertain whether the records are based on escapees from introduced populations or whether the species is native.

Cyprinodontidae — killifishes

Fundulus catenatus (Storer). Northern studfish. F,G,H,J. Common in the upper Barren, Green, Salt and Cumberland rivers. Also known from a tributary of the Kentucky River, Lincoln County (EKU, UMMZ), and Dix River, Rockcastle County (WKU). A preimpoundment record from a tributary of the lower Cumberland River, Caldwell County (KFW), needs substantiation.

Fundulus chrysotus (Günther). Golden topminnow. A. Known only from Open Pond (Reelfoot Lake drainage), Fulton County, where it is uncommon (Sisk 1973).

Fundulus notatus (Rafinesque). Blackstripe topminnow. A,C,D,E,

F,G,J,K. Occasional to common in the lower Licking, Kentucky, Salt and Green River systems. Uncommon in the Cumberland River below Lake Cumberland. Usually replaces *F. olivaceus* in lowland swamps and ditches of region A.

Fundulus notti (Agassiz). Starhead topminnow. A. Known from two localities in extreme western Kentucky: Open Pond, Fulton County (Sisk 1973), and Murpheys Pond, Hickman County (Branson 1972).

Fundulus olivaceus (Storer). Blackspotted topminnow. A,B,C,D,E. Abundant from the Tradewater River westward. Sporadic in the lower Green River where the few specimens available are somewhat intermediate in appearance between *F. notatus* and *F. olivaceus*. Specimens of this species reported from Martin's Fork, Harlan County (Clay 1975) could not be located.

Poeciliidae — livebearers

Gambusia affinis (Baird and Girard). Mosquitofish. A,B,C,D,E,F, G,H,J,K. Abundant and ubiquitous in the Coastal Plain, the lower Green River and its tributaries, and the Salt River and other tributaries along the Ohio River, where it is presumed to be native. Probably introduced into the Kentucky, Licking and upper Cumberland Rivers for mosquito control. Several records are now available from the presumed areas of introduction.

Atherinidae — silversides

Labidesthes sicculus (Cope). Brook silverside. A,C,D,E,F,G,H, J,K,L. Generally distributed throughout the state in or near large to medium-size rivers, lakes and reservoirs, and bottomland swamps, lakes and sloughs.

Menidia audens Hay. Mississippi silverside. A. Known only from the main channel of the Mississippi River and two localities in extreme southwestern Fulton County, where the species was first reported from Kentucky by Sisk (1973).

Cottidae — sculpins

Cottus bairdi Girard. Mottled sculpin. J,K,L. Unevenly distributed in the upper Kentucky and upper Licking rivers and region L. A record from Clear Creek, Rockcastle County (Branson and Batch 1972) needs verification.

Cottus carolinae (Gill). Banded sculpin. D,E,F,G,H,J. Generally distributed from the lower Cumberland River system eastward to and including the Kentucky river system, avoiding lowland areas in Region E.

Percichthyidae — temperate basses

Morone chrysops (Rafinesque). White bass. A,C,D,E,F,G,H,J. Occasional in the main channels of the Ohio and Mississippi rivers and

their major tributaries. I am unaware of any confirmed records from the Licking, Big Sandy and Salt rivers, although the species probably occurs in those drainages.

Morone mississippiensis Jordan and Eigenmann. Yellow bass. A,C,D. Limited to the main channels of the lower Cumberland, lower Tennessee, Mississippi and lower Ohio rivers, where it is uncommon.

Morone saxatilis (Walbaum). Striped bass. C,D,F,H,J,L. Introduced. Continually restocked in several of the manmade lakes throughout Kentucky. I have captured escapees and seen specimens from the main channels of the lower Ohio, lower Tennessee and Mississippi rivers.

Centrarchidae — sunfishes

Ambloplites rupestris (Rafinesque). Rock bass. D,E,F,G,H,J,K,L. Generally distributed throughout the eastern two-thirds of the state avoiding lowland areas in region E. Stragglers are known from as far west on the Ohio River as Union County.

Centrarchus macropterus (Lacépède). Flier. A,C,D,E. Sporadic to occasional in extreme western Kentucky and the lower Green River and its tributaries (over 10 recent records). One record from the lower Cumberland River drainage, Livingston County (INHS), and one from Clarks River, Marshall County (SIUC).

Elassoma zonatum Jordan. Banded pygmy sunfish. A,B,C,E. Formerly thought to be restricted to the Coastal Plain, where it is common in swamps, ditches, and lowland streams. Recently discovered in Cypress Creek, Muhlenberg County, (KNP, SIUC) and Terrapin Creek, Graves County (SIUC). A record from West Fork Clarks River, Graves County (Sisk 1969), needs substantiation.

Lepomis auritus (Linnaeus). Redbreast sunfish. D,H,J. Introduced. Specimens from introduced populations are available from Little River, Trigg County (MSU), upper Cumberland River, Bell County (KFW), and Kentucky River, Franklin County (UL). If this species has successfully become established in Kentucky waters, the fact has not been confirmed.

Lepomis cyanellus Rafinesque. Green sunfish. A,B,C,D,E,F,G,H, J,K,L. Generally distributed throughout the state.

Lepomis gibbosus (Linnaeus). Pumpkinseed. Known from only two localities in the Ohio River in Jefferson and Campbell counties. Inclusion of this species in the Kentucky fish list is probably based on escapees from introductions to commercial fishing lakes and farm ponds.

Lepomis gulosus (Cuvier). Warmouth. A,B,C,D,E,F,G,H,J,K. Occasional from the Licking River drainage westward, but most common from the lower Green River basin westward.

Lepomis humilis (Girard). Orangespotted sunfish. A,C,D,E,F,G,H, J,K,L. Occasional to common in the Coastal Plain, sporadic throughout the rest of the state.

Lepomis macrochirus Rafinesque. Bluegill. A,B,C,D,E,F,G,H, J,K,L. Abundant and generally distributed throughout the state.

Lepomis marginatus (Holbrook). Dollar sunfish. A,B. Known only from Murpheys Pond, Hickman County (SIUC), where it is uncommon (Burr and Mayden 1979), and Terrapin Creek, Graves County (SIUC), where five specimens were recently taken.

Lepomis megalotis (Rafinesque). Longear sunfish. A,B,C, D,E,F,G,H,J,K,L. Abundant throughout the state.

Lepomis microlophus (Günther). Redear sunfish. A,C,D,E,F,G, J,K,L. Sporadic and uncommon throughout the state, excluding the upper Cumberland River drainage. Several records from eastern Kentucky probably are based on introductions.

Lepomis punctatus (Valenciennes). Spotted sunfish. A. Known from seven localities in extreme western Kentucky (INHS, SIUC), where it is taken from lowland streams and lakes (Burr and Mayden 1979) and never appears to be common.

Lepomis symmetricus Forbes. Bantam sunfish. A. Known from six localities in extreme western Kentucky (INHS, MSU, UL, SIUC), where it is sometimes common (e.g., in Murphey's Pond, Hickman County).

Micropterus coosae Hubbs and Bailey. Redeye bass. H. Introduced. Known only from Martins Fork and tributaries, Bell County (UL). Although the provenance of this population is unknown (Clay 1975) it seems highly unlikely that the species is native to Kentucky.

Micropterus dolomieui Lacépède. Smallmouth bass. C,D,E,F,G,H, J,K,L. Generally distributed in upland streams throughout the eastern two-thirds of Kentucky. Occasional in the Land Between the Lakes area, where it was more common before impoundment.

Micropterus punctulatus (Rafinesque). Spotted bass. A,C,D,E,F, G,H,J,K,L. Generally distributed throughout the state except in the extreme west, where it is uncommon.

Micropterus salmoides (Lacépède). Largemouth bass. A,C,D,E, F,G,H,J,K. Generally distributed throughout the state, except for region L.

Pomoxis annularis Rafinesque. White crappie. A,C,D,E,F,G,H, J,K,L. Generally distributed in lakes and rivers throughout the state.

Pomoxis nigromaculatus (Lesueur). Black crappie. A,C,D,E,F,G,H, J,K. Sporadic in lakes and rivers throughout the state except for region L. Records indicate that it is less common than the white crappie.

Percidae — perches

Ammocrypta asprella (Jordan). Crystal darter. D,F. Known from four old records: Cumberland River, Lyon County (FMNH), Green River, Edmonson County (USNM), Green River, Green County (UMMZ), and Ohio River, Greenup-Boyd counties (CAS-SU). Not collected in Kentucky since 1929 and considered extirpated.

Ammocrypta clara Jordan and Meek. Western sand darter. F,H. Known from two localities: Green River, Green County (Woolman 1892), and Cumberland River, Wayne County (UMMZ). Not collected in Kentucky since 1925, when it was recorded from the part of the Cumberland River now impounded as Lake Cumberland. Probably extirpated.

Ammocrypta pellucida (Putnam). Eastern sand darter. E,F,J,K,L. Recent collecting effort indicates that this species, which was formerly reasonably common in eastern Kentucky, is rapidly declining in numbers. Probably still present in portions of the Green, Kentucky, Licking, Big Sandy and Ohio rivers.

Ammocrypta vivax Hay. Scaly sand darter. C. Known only from two specimens taken in a preimpoundment study of the lower Tennessee River. The specimens are from Jonathon Creek, Marshall County (UMMZ), and were reported by Starnes et al. (1977). Probably extirpated, since most of lower Jonathon Creek is now part of the impounded waters of Kentucky Lake.

Etheostoma asprigene (Forbes). Mud darter. A,D,E. Most collections come from areas bordering the Mississippi and lower Ohio rivers. Seven recent collections (KNP, SIUC) are available from the lower Green River drainage. Common at some localities in extreme western Kentucky.

Etheostoma atripinne (Jordan). Cumberland snubnose darter. D,H. An uncommon species known from six localities in the Cumberland River drainage in Todd, Logan, Wayne and Pulaski counties.

Etheostoma barbouri Kuehne and Small. Teardrop darter. E,F. Endemic to the upper Barren and upper Green rivers where it is common in small to medium-size streams.

Etheostoma bellum Zorach. Orangefin darter. F. Endemic to the upper Green and Barren rivers where it is common in fast, gravel and boulder riffles.

Etheostoma blennioides Rafinesque. Greenside darter. D,E,F,G,H, J,K,L. Generally distributed from the lower Cumberland River, Trigg County, eastward, avoiding most of the lowlands in region E.

Etheostoma caeruleum Storer. Rainbow darter. C,D,E,F,G,H,J,K,L. Generally distributed from the Land Between the Lakes area eastward, avoiding the lowland areas in region E.

Etheostoma camurum (Cope). Bluebreast darter. H,J. Found only in the upper Cumberland River drainage below Cumberland Falls, and the upper Kentucky River drainage.

Etheostoma chlorosomum (Hay). Bluntnose darter. A,C,D,E. Common in the lower Cumberland River and westward. Three recent records from the Tradewater River drainage (SIUC). A record from Caney Creek, Grayson County (UL), needs substantiation.

Etheostoma cinereum Storer. Ashy darter. D,H. Known only from

the Cumberland River drainage where it is rare. Five records are available: Red River, Logan County (UMMZ), Little South Fork of the Cumberland River, Wayne County (UT), Buck Creek, Pulaski County (UMMZ), Rockcastle River, Rockcastle County (KNP), and Big South Fork of the Cumberland River, McCreary County (KNP).

Etheostoma flabellare Rafinesque. Fantail darter. C,D,E,F,G,H, J,K,L. Generally distributed and abundant from Clarks River eastward, avoiding the lowland areas in region E.

Etheostoma fusiforme (Girard). Swamp darter. A. Known only from two localities in the Reelfoot Lake drainage in extreme southwestern Fulton County (Sisk 1973).

Etheostoma gracile (Girard). Slough darter. A,B,C,D,E. Generally distributed and common from the lower Green River westward.

Etheostoma histrio Jordan and Gilbert. Harlequin darter. A,B,C,E. Uncommon and sporadic in the lower portions of Obion Creek, Bayou du Chien, and Mayfield Creek (Sisk and Webb 1976). Formerly known from Blood River, Calloway County (UL), and Rough River, Ohio County (Woolman 1892).

Etheostoma kennicotti (Putnam). Stripetail darter. C,D,E,F,H. Common in upper Clarks, Tradewater, upper Pond, upper Rough, upper Green and upper Cumberland rivers, and a few small tributaries of the Ohio River in Livingston and Crittenden counties. A record from the Licking River drainage, Bath County (Bauer and Branson 1979), needs verification.

Etheostoma maculatum Kirtland. Spotted darter. F,H,K. Uncommon in the upper Green, upper Barren and upper Cumberland rivers. Woolman (1892) reported this species from South Fork Licking River where it has not been reported since.

Etheostoma microlepidum Raney and Zorach. Smallscale darter. D. Known from only three localities in Kentucky, all from the lower Cumberland River drainage: Little River, Trigg County (UMMZ), Little River, Trigg-Christian counties (UMMZ), and Red River, Logan County (EKU).

Etheostoma microperca Jordan and Gilbert. Least darter. G. Known from only one specimen collected in Beargrass Creek, Jefferson County (UL). Other records reported by Clay (1975) were based on misidentifications of other species (Burr 1978). Woolman's (1892) record for the Little Barren River, Green County, is probably an error (Burr 1978). Recent collecting in Beargrass Creek has not revealed the presence of this species and it may be extirpated.

Etheostoma neopterum Howell and Dingerkus. Lollypop darter. C. Found in Kentucky only in tributaries of the Tennessee River, where it is abundant (Burr and Mayden 1979).

Etheostoma nigrum Rafinesque. Johnny darter. B,C,D,E,F,G,H, J,K,L. Sporadic in distribution in the western half of the state but com-

mon and evenly distributed in the eastern half. Rare in the upper Cumberland River drainage (Starnes and Starnes 1979).

Etheostoma obeyense Kirsch. Barcheek darter. H. Known only from the upper Cumberland River below Cumberland Falls, where it is occasional to common in small to medium-size creeks (Page and Braasch 1976).

Etheostoma parvipinne Gilbert and Swain. Goldstripe darter. B,C. Known from four localities in western Kentucky: Terrapin and Powell creeks, Graves County (SIUC), and Sugar Creek (SIUC) and Billie Branch, Calloway County (MSU). Occurrences are sporadic and at certain times of the year the species is very hard to find (Burr and Mayden 1979).

Etheostoma proeliare (Hay). Cypress darter. A,C,D. Rare to occasional in sloughs and lakes that border the Mississippi and lower Ohio rivers. Two records are available from the lower Cumberland River drainage, Livingston County (INHS), and five from the lower Tennessee River drainage (SIUC, UMMZ). Three of the latter were taken before impoundment (Burr and Mayden 1979).

Etheostoma rufilineatum (Cope). Redline darter. C,D,H. Uncommon to occasional in the Tennessee and Cumberland River drainages. Somewhat disjunct in Clarks River where specimens display some morphological differentiation from other populations.

Etheostoma sagitta (Jordan and Swain). Arrow darter. H,J. Occasional in the upper Cumberland and upper Kentucky river drainages.

Etheostoma smithi Page and Braasch. Slabrock darter. D. Known only from the lower Cumberland River drainage, where it is sometimes common in small headwater creeks (Page and Braasch 1976).

Etheostoma spectabile (Agassiz). Orangethroat darter. A,C, D,E,F,G,H,J,K,L. Sporadic in distribution but common. Populations of this species in western Kentucky are limited to Mayfield Creek, Land Between the Lakes, and upper Pond River. The species is more evenly distributed from the Salt River eastward to the upper part of region L.

Etheostoma squamiceps Jordan. Spottail darter. D,E,F. An abundant species in the lower Cumberland River and adjacent small creeks tributary to the Ohio River in Livingston and Caldwell counties, and upper Pond, Barren, Nolin, Rough, and Green rivers. Specimens reported from Bayou du Chien by Webb and Sisk (1975) are under study by other workers.

Etheostoma stigmaeum (Jordan). Speckled darter. C,D,E,F,H. Occasional to common in Clarks, upper Rough, upper Green, upper Barren and upper Cumberland (below the falls) rivers.

Etheostoma swaini (Jordan). Gulf darter. B. Occurs only in tributaries of Obion River, Graves County (SIUC), where it is occasional to common (Burr and Mayden 1979).

Etheostoma tippecanoe Jordan and Evermann. Tippecanoe darter.

F,H,J,K. Uncommon in the Green River, Green County (UMMZ), the upper Kentucky River drainage, Owsley County (UL, UMMZ), and Big South Fork of the Cumberland River, McCreary County (KNP). Occasional in the middle part of the Licking River (KFW, UL).

Etheostoma variatum Kirtland. Variegate darter. J,K,L. Generally distributed throughout the upper Kentucky and Licking River systems, and all of region L where it may be common in swift riffles.

Etheostoma virgatum (Jordan). Striped darter. D,H. Known only from the Cumberland River drainage, where it is common in Red River, Todd and Logan counties, and Buck Creek and Rockcastle River tributaries below the falls in the upper Cumberland River.

Etheostoma zonale (Cope). Banded darter. B,E,F,G,H,J,K,L. Unevenly distributed in the eastern two-thirds of the state. Specimens from region B represent the distinctive subspecies *E. z. lynceum.*

Etheostoma species. Undescribed. Golden snubnose darter. C,D. Generally distributed throughout the lower Cumberland River drainage in Kentucky. There is one preimpoundment record from the lower Tennessee River drainage (UMMZ).

Etheostoma species. Undescribed. Emerald darter. H,J. Common in parts of the upper Cumberland and Kentucky River drainages.

Etheostoma species. Undescribed. Lowland snubnose darter. C. Abundant in Clarks and Blood River drainages, and there is one preimpoundment record from the lower Tennessee River.

Etheostoma species. Undescribed. Red snubnose darter. B. Occasional in Terrapin Creek, Graves County (SIUC).

Etheostoma species. Undescribed. Splendid darter. F. Endemic to the upper Barren River system where it is common in pools and raceways.

Etheostoma species. Undescribed. Green River snubnose darter. F. Endemic to the upper Green River system where it is occasional to sporadic.

Perca flavescens (Mitchill). Yellow perch. D. Sporadic and rare in the main channel of the Ohio River; one record from the lower Cumberland River is probably an introduction. It is not certain whether the individuals that occasionally appear in the Ohio River are stragglers from native populations in other parts of the species' range or escapees from introduced populations.

Percina burtoni Fowler. Blotchside logperch. H. Known from one record from Little South Fork of the Cumberland River, Wayne County (Woolman 1892). Some of the specimens that Woolman called *P. caprodes* were later reidentified as *P. burtoni* by Robert E. Jenkins (Comiskey and Etnier 1972). Probably extirpated in Kentucky, although Comiskey nearly missed capturing what he thought was this species during his survey of fishes of the Big South Fork of the Cumberland River (Comiskey and Etnier 1972).

Percina caprodes (Rafinesque). Logperch. A,C,D,E,F,G,H,J,K,L. Generally distributed from Clarks River eastward. Three records exist from the extreme lower Ohio (INHS) and Mississippi River systems (SIUC).

Percina copelandi (Jordan). Channel darter. C,F,H,J,K,L. Sporadically distributed and uncommon in the upper Green, upper Cumberland (below the falls), upper Kentucky, middle Licking and upper Big Sandy rivers. One preimpoundment record from Blood River, Calloway County (UMMZ), is extant.

Percina evides (Jordan and Copeland). Gilt darter. C,F,J,K,L. Uncommon in the upper Green, upper Kentucky, middle Licking and upper Barren rivers. There is a preimpoundment record from Blood River, Calloway County (UMMZ).

Percina macrocephala (Cope). Longhead darter. F,H,J,K,L. Sporadic in the upper Barren, upper Green, Kentucky, and Licking rivers and region L. Kirsch (1893) collected this species from Little South Fork of the Cumberland River, Wayne County, but it has not since been reported from the Cumberland River system in Kentucky. This species once was common in the upper Barren River, as indicated by the many specimens collected by KFW personnel using rotenone (Page 1978).

Percina maculata (Girard). Blackside darter. A,C,D,E,F,G,H,J,K,L. Generally distributed throughout the state from Clarks River eastward. Two records from Obion Creek, Hickman County (MSU), are known.

Percina ouachitae (Jordan and Gilbert). Ouachita darter. A,C,E. This species, formerly known in Kentucky by the name *P. uranidea,* is common in Obion Creek and Bayou du Chien. Single records from Blood River, Calloway County (UL), and Jonathon Creek, Marshall County (UMMZ), are preimpoundment collections. Woolman (1892) reported this species from Rough River, Ohio County (USNM), and his specimens were verified by Williams and Etnier (1977).

Percina oxyrhyncha (Hubbs and Raney). Sharpnose darter. J,K,L. Specimens originally labeled *P. phoxocephala* were recently reidentified as *P. oxyrhyncha* by Thompson (1978), and the species is now known to be present in the upper Kentucky, upper Licking and upper Big Sandy drainages.

Percina phoxocephala (Nelson). Slenderhead darter. C,D,E,F,G,J. Present prior to impoundment in the lower Cumberland and Tennessee rivers. Occasional throughout the Green and Salt River systems and the lower Kentucky River drainage (Eagle Creek). Woolman (1892) recorded it from Mayfield Creek.

Percina sciera (Swain). Dusky darter. A,B,C,D,E,F,G,H,J,L. Sporadic throughout the entire state except the Licking River system, from where I have been unable to locate specimens.

Percina shumardi (Girard). River darter. C,D,E,F,J,K. Sporadic and uncommon in the main channel of the Mississippi and Ohio rivers and

the lower Tennessee, upper Green, upper Kentucky and middle Licking rivers. Woolman's (1892) records of this species from the lower Cumberland and lower Rough rivers have not been confirmed by recent collecting efforts in these areas, but are considered valid.

Percina squamata (Gilbert and Swain). Olive darter. H. Known from five localities in Rockcastle River, Rockcastle and Jackson counties (EKU, UMMZ), and Big South Fork of the Cumberland River, McCreary County (KFW; specimens discarded). Clay's (1975) record of this species from the Tennessee River, Marshall County, needs verification, but I have been unable to locate the specimens on which the record was based.

Percina species. Undescribed. Blackfin darter. F,J. This species was long known under the name *P. cymatotaenia,* but is an undescribed species common in the upper Barren, upper Green and upper Kentucky River systems. The report of this species from Obion Creek (Smith and Sisk 1969) was based on *P. sciera.*

Stizostedion canadense (Smith). Sauger. A,C,D,E,F,G,H,J,K,L. Occasional in the main channels of the Ohio and Mississippi rivers and the lower reaches of their major tributaries.

Stizostedion vitreum (Mitchill). Walleye. C,D,E,H,K,L. Sporadic and uncommon in the main channels of the Ohio and Mississippi rivers and the Tennessee, Cumberland, Licking and Big Sandy rivers.

Sciaenidae — drums

Aplodinotus grunniens Rafinesque. Freshwater drum. A,C,D,E,F, G,H,J,K,L. Generally distributed throughout the Ohio and Mississippi rivers and their major tributaries; occasional in medium-size rivers throughout the state.

PROBLEMATICAL LIST OF SPECIES

The five species in the following list of hypothetical additions to the Kentucky fauna represent one family and three genera.

Cyprinidae — minnows and carps

Campostoma oligolepis Hubbs and Greene. Largescale stoneroller. There is little question that this species (probably a new subspecies) occurs in Kentucky in the lower Tennessee, lower Cumberland and upper Green River drainages. However, until a thorough study of variation is completed I have chosen to refer to stonerollers in Kentucky as *C. anomalum.*

Notropis coccogenis (Cope). Warpaint shiner. Recorded by Woolman (1892) from the big Sandy River, but the specimens have not been located and the record is probably an error (Gilbert 1964). A specimen from Cumberland Gap, Bell County, collected by Walter Faxon in 1875, is available (UMMZ). Except for Woolman's record and

Faxon's specimen, the species has been considered endemic to the Tennessee River drainage.

Notropis heterolepis Eigenmann and Eigenmann. Blacknose shiner. Reported by Turner (1959) from Rough River, but no specific locality was given and no specimens from the state are known to exist. Since *N. boops* is present in the same area and is superficially similar, I assume the record of *N. heterolepis* was actually based on *N. boops*. However, there is a relict population of *N. heterolepis* in central Tennessee, so it possibly occurs or once did occur in Kentucky. Until a verified record is available, however, it seems best to delete it from the state faunal list.

Notropis hubbsi Bailey and Robison. Bluehead shiner. Known from adjacent southern Illinois in Wolf Lake, Union County (Bailey and Robison 1978, Smith 1979), and should be looked for in lowland lakes in western Kentucky.

Rhinichthys cataractae (Valenciennes). Longnose dace. Known from the Cumberland River in adjacent Tennessee where it is sporadically distributed. Possible in the upper Cumberland and Big Sandy River drainages, Kentucky.

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New Species Groups of *Pseudanophthalmus* from the Central Basin of Tennessee (Coleoptera: Carabidae: Trechinae)

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ABSTRACT.—Two new species groups of *Pseudanophthalmus* are proposed. The *simplex* group includes *P. simplex* n. sp. and *P. fowlerae* n. sp. The *cumberlandus* group includes *P. cumberlandus* Valentine, *P. productus* n. sp., and *P. inquisitor* n. sp.; the following are full species and also belong to the *cumberlandus* group: *tiresias, catherinae, insularis, occidentalis, acherontis, tullahoma,* and *bendermani.* All species discussed occupy caves in the Central Basin of Tennessee.

Cave carabids of the very large genus *Pseudanophthalmus* Jeannel (about 200 species) have traditionally been arranged in "species groups" — neutral categories of supposedly monophyletic species assemblages which are of lower rank than subgenera. The comparative homogeneity of the genus does not readily permit division into clearly distinguishable subgenera, but within certain limits there is substantial diversity at the species group level. In preparing a new classification of *Pseudanophthalmus* I was unable to assign two undescribed species from Jackson and Clay counties, in the upper Cumberland River basin, Tennessee, to an existing group. These species are described in the present paper and placed in the new *simplex* group. Two other species with which they are sympatric are close to *P. cumberlandus* Valentine, which I have made the type species of a widely distributed new group, the *cumberlandus* group. This group, occurring throughout the Central Basin of Tennessee and with species in southwestern and southeastern Kentucky, the western Tennessee River valley in Tennessee, and one county in north Alabama, is the largest species group in the genus, including about 30 species.

simplex group (new group)

Size medium (4.0-5.1 mm); robust, depressed; moderately pubescent to nearly glabrous; elytral microsculpture a fine, transverse meshwork, with hint of pruinosity in one species. Pronotum transverse, hind angles right or nearly right. Labrum doubly emarginate. Anterior discal puncture at level of 4th umbilicate; apical groove subparallel or slightly oblique to suture, connected obliquely to 3rd stria in advance of anterior apical puncture, or running to this puncture via prominent crosier; humeri finely serrulate. Mentum tooth broad, emarginate. Mesosternum

declivous. Last abdominal sternite of males with apical margin entire. Aedeagus scarcely arcuate, basal bulb not conspicuously enlarged nor deflexed, apex gradually attenuate and bluntly rounded at tip, only feebly produced; transfer apparatus with rather heavily sclerotized right piece, medially concave, apex knobbed or not, and broadly triangular, membranous, spiny left piece with apex spatulate and twisted 90°, or right piece as described and left piece absent; parameres moderately slender, bearing 4 long setae at their apexes. Type species: *P. simplex,* new species.

Discussion.—This group consists of only two known species that occur in caves of Jackson and Clay counties, Tennessee, at the northeast edge of the Central Basin, in Ordovician limestones of the upper Cumberland River drainage, on the south (left) side of the river. The somewhat isolated troglobitic crayfish species *Orconectes incomptus* (Hobbs and Barr 1972) also occurs in caves of this region.

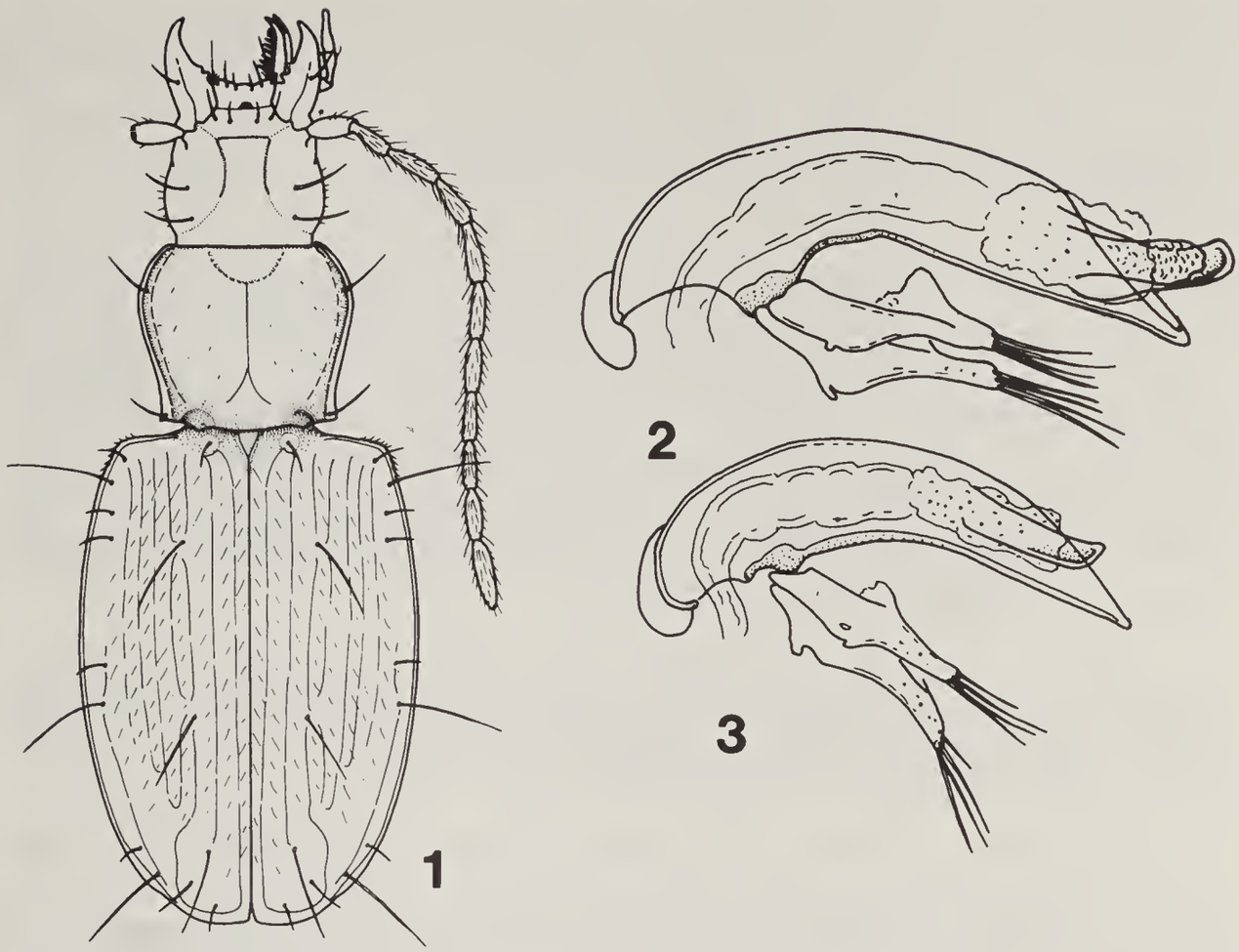
The form of the copulatory sclerites and the serrulate humeri suggest a close relationship with the *pubescens* group (see Barr 1979); very faint pruinose microsculpture on the elytra of one species is additional evidence favoring this view. Different features, however, require the establishment of a distinct group: depressed, robust form; more posterior position of the anterior discal puncture (pleomorphic); reduced pubescense and reduced pruinose microsculpture (probably apomorphic); and the general form of the aedeagus. The transfer apparatus in *simplex* itself is similar in basic pattern to that of the *pubescens* group.

One can speculate that the *simplex* group may be a link between the *pubescens* and *menetriesi* groups on the one hand and the numerous, small to medium species of the *cumberlandus* group on the other. In the *cumberlandus* group there is a single copulatory piece, presumably the left one; its simple structure, together with the apparent loss of the right piece, deprive the phylogenist of a key character in inferring relationships of the group to other *Pseudanophthalmus* species groups. The left copulatory piece in *simplex* is close enough to the *cumberlandus* transfer apparatus that a relationship is at least feasible. Habitus and geographic distribution of the *simplex* group, although weaker evidence supporting a relationship to the *cumberlandus* group, are at least consonant with an hypothesis that the two groups are phylogenetically close.

Pseudanophthalmus simplex, new species
Figs. 1, 2

Etymology.—Latin *simplex,* "simple."

Diagnosis.—With the characters of the group as defined above; two copulatory pieces present; elytral striae deeper, impunctate; elytral microsculpture with a few pruinose patches near center of disc, which is moderately pubescent; apical groove longer.



Figs. 1-3. *Pseudanophthalmus: simplex* group. 1. *P. simplex,* n. sp. (4.6 mm). 2. Aedeagus, *P. simplex* n. sp. (0.86 mm). 3. Aedeagus, *P. fowlerae,* n. sp. (0.68 mm).

Description.—Length 4.2-5.1, mean 4.6 mm. Form robust and depressed; elytral microsculpture finely transverse, forming meshes, with trace of pruinose microsculpture near middle of disc, scarcely discernible (50X). Head rounded, as wide as long; labrum distinctly trilobed. Pronotum transverse, 0.8 as long as wide, disc feebly convex and very sparsely pubescent; sides strongly arcuate in apical 0.8, subparallel in basal 0.2; front angles rounded, apex about 0.85 maximum width, which occurs at apical 0.20-0.22, base width nearly equal to maximum width, hind angles large and more or less right or slightly acute, depending on development of lateral emargination of base and secondary angles, which are variably developed but always present in some form. Elytra more than 1.5 times as long as wide, depressed, moderately pubescent; humeri angular, somewhat obsoletely serrulate, prehumeral border not quite perpendicular to midline; inner 4 longitudinal striae moderately impressed, intervals convex, outer striae obsolete; apical groove subparallel or slightly oblique to suture, running to third stria in advance of anterior apical puncture or running to anterior apical puncture via prominent crosier. Aedeagus 0.78-0.89, mean 0.83 mm long; feebly arcuate, basal bulb not appreciably expanded and not deflexed, apex gradually attenuate, scarcely produced, rounded at tip; right copulatory piece a more or

less hyaline hemisheath, its apex a bluntly rounded knob, left piece a little shorter, broadly triangular, densely but minutely spiny, with apex twisted 90° to right and thus appearing as narrow, nipplelike or broadly spatulate, depending on orientation; parameres rather slender, with 4 apical setae.

Type series.—Holotype male (American Museum of Natural History) and one female paratype, Carter Cave, 5.5 km ssw of Flynns Lick, Jackson Co., Tennessee, 23 October 1960, T. C. Barr. Two additional paratypes from same cave, 9 June 1955 and 20 July 1957, T. C. Barr. Three paratypes from Hailes Cave, 0.5 km n of Flynns Licks, 6 May 1959, T. C. Barr, and 19 October 1948, J. M. Valentine and W. B. Jones. (See Barr 1961 for detailed locations and descriptions of these and other caves mentioned in this paper.)

Measurements (in mm).—Holotype male, total length 4.60, head 0.80 long X 0.80 wide, pronotum 0.90 long X 1.10 wide, elytra 2.66 long X 1.72 wide, antenna 3.06, aedeagus 0.86 long.

Distribution.—The material seen of this species includes the type series of 7 specimens and one specimen (not a paratype) from Cherry Cave, northeast Jackson County, Tennessee. The three caves from which the species is known are located at the northeast edge of the Central Basin in the upper Cumberland River drainage; all of the caves are on the south (left) side of Cumberland River.

Discussion.—In Carter Cave the species occurs sympatrically and syntopically with a more abundant species, *P. productus,* of the *cumberlandus* group, under rocks and on silt banks by the cave stream. Females and undissected males can be distinguished by the more robust and more depressed form and by the deeper elytral striation. The aedeagus of *simplex* has a shorter and less produced apex than that of *productus,* and the transfer apparatus consists of two prominent sclerites instead of the small, single, very slender sclerite characteristic of the *cumberlandus* group.

Pseudanophthalmus fowlerae, new species
Fig. 3

Etymology.—Patronymic honoring Mrs. Otia Fowler, owner of the type locality cave.

Diagnosis.—Differs from *simplex* in shallow, irregularly punctate elytral striae, glabrous and non-pruinose elytral disc, microsculpture with

denser, transverse meshes; apical groove a little shorter; left copulatory piece absent.

Description.—Length 4.0-4.6, mean 4.3 mm. Form as in *simplex* but paler, slightly more depressed, virtually glabrous, elytral disc highly polished, transverse meshworks of microsculpture denser, and no trace of pruinose microsculpture. Head slightly transverse, labrum doubly emarginate. Pronotum as in *simplex*. Elytra with longitudinal striae more shallowly impressed, feebly punctulate, inner 3 striae regular, fourth stria irregular, outer striae obsolete. Aedeagus 0.66-0.70, mean 0.68 mm, of same form as that of *simplex* but a little smaller and apex even less produced; transfer apparatus a single sclerite, apparently homologous to right piece of *simplex*: large, rather heavily sclerotized, margins parallel, concave to left, apex bluntly rounded but scarcely knobbed.

Type series.—Holotype male (American Museum of Natural History) and 4 paratypes, Sheals Cave, 0.8 km e of Celina, Clay Co., Tennessee, 3 December 1960, T. C. Barr. Six additional paratypes, Sheals Cave, 28 February 1959, 7 April 1960, and 11 August 1965, T. C. Barr and J. R. Holsinger.

Measurements (in mm).—Holotype, total length 4.04, head 0.70 long X 0.74 wide, pronotum 0.76 long X 0.90 wide, elytra 2.20 long X 1.48 wide, antenna 2.80, aedeagus 0.68.

Distribution.—Known only from the type locality cave, from which 11 specimens are available.

Discussion: Two beetles collected in August, 1965, are late tenerals, suggesting midsummer eclosion. Most of the specimens were taken under rocks in a depression in the floor of the entrance room, well within the twilight zone, in an area kept moist by a constant drip from the ceiling, or from the damp silt floor in a small domepit or along the cave stream not far from the entrance. The entrance room is approximately 75 m long, and the cave extends another 180 m along a narrow stream channel. The species is sympatric with *P. inquisitor,* which is noticeably smaller and belongs to the *cumberlandus* group. Both species are about equally abundant, judging from the size of the type series (11 *fowlerae,* 10 *inquisitor*), which were obtained on four separate visits to the cave.

cumberlandus group (new group)

Size small to medium (3-5 mm); moderately pubescent, form variable, usually rather slender and depressed, robust and convex in a few

larger species; elytral microsculpture a fine, tranverse meshwork, pruinose only in species from Rockcastle, Pulaski, and Wayne counties, Kentucky. Labrum doubly emarginate, the median lobe varying from weak to moderately prominent. Anterior discal at level of 4th umbilicate; apical groove typically short and very rounded, joining 3rd stria at or slightly anterior to anterior apical puncture; humeri weakly serrulate or not serrulate. Mentum tooth broad, short, emarginate. Mesosternum declivous. Last abdominal sternite of males with apical margin entire. Aedeagus weakly and evenly arcuate, basal bulb not conspicuously enlarged nor deflexed, aedeagal apex usually slender, more or less produced, not very attenuate, bluntly rounded at tip; transfer apparatus consisting of a single slender, small, elongate-triangular copulatory sclerite; parameres rather short, with 4 setae at their apexes. Type species: *P. cumberlandus* Valentine.

Discussion.—Pseudanophthalmus cumberlandus was placed in the *pubescens* group by Jeannel (1949). Barr (1959) previously relegated 7 taxa described as polytypic *P. tiresias* to a section of the *engelhardti* group, where they do not belong; they are small, mostly slender and depressed species, but all have the typical *cumberlandus* group transfer apparatus. Further study of the *tiresias* complex indicates that all 7 taxa are full species.

The group is widely distributed in the Central Basin of Tennessee but also extends into north Alabama (Limestone County), western Kentucky (Christian, Caldwell, and Livingston counties), eastern Kentucky (Rockcastle, Pulaski, and Wayne counties), the eastern Highland Rim of Tennessee (Coffee County), and the western Highland Rim and western valley of the Tennessee River in Tennessee (Montgomery, Dickson, Hickman, and Lewis counties). In numbers of species (approximately 30) the group exceeds the *engelhardti* group. The aedeagal form and simple copulatory sclerite are highly diagnostic; the single sclerite is probably homologous with the left piece of other groups. Some of the component species, especially those at the periphery of the group's collective range, are sympatric with species of the *pubescens, menetriesi,* and *simplex* groups. Some of the species in the southeastern and western parts of Middle Tennessee are geographically close to species of the *engelhardti* group (*P. loedingi humeralis* Valentine and *P. hesperus* Barr, respectively), but no sympatry has been demonstrated. In the case of the sympatric species pair *P. productus/P. simplex* the body size is approximately the same (4.2-5.4 mm and 4.2-5.1 mm respectively), and in the pair *P. inquisitor/P. fowlerae* the former species is much smaller (3.1-3.9 vs. 4.0-4.6 mm, respectively). The species of the *pubescens* and *menetriesi* groups are invariably conspicuously larger than species of the *cumberlandus* group with which they coexist.

Pseudanophthalmus cumberlandus Valentine

Valentine 1937:96. Type locality, Piper Cave, Smith Co., TN.

The species is seasonally abundant in damp areas of Piper Cave, especially on previously flooded muddy floors and around rimstone pools and bat guano, but it is usually rare or absent in winter. Unlike the majority of the species in the group, *P. cumberlandus* is unusually robust and convex, with prominent humeri and nearly perpendicular prehumeral borders, the elytral striae very shallow. I have also taken it in Skeleton Cave, Smith County, and Ann White Cave, Macon County, Tennessee.

Pseudanophthalmus productus, new species
Fig. 5

Etymology.—Latin *productus,* "produced."

Diagnosis.—Closely similar in the robust, convex body form and nearly perpendicular prehumeral borders to *P. cumberlandus* Valentine, differing in denser pubescence, wider pronotum base, deeper elytral striae, and long, produced, aedeagal apex.

Description.—Length 4.2-5.4, mean 4.9 ± S.E. 0.3 mm (N =35). Form robust and convex, pubescent, rufotestaceous. Head about 0.1 longer than wide; labrum doubly emarginate; antenna 0.7 body length. Pronotum 0.87 as long as wide, transverse-subquadrate; base wider than apex and 0.8 maximum width, which occurs in apical third; sides sinuate in basal sixth, but very shallowly so, hind angles about right, sometimes slightly acute or slightly obtuse, feebly emarginate behind, secondary angles present but rather subdued. Elytra 1.6 times longer than wide, prehumeral borders nearly perpendicular to midline, humeri prominent and serrulate, inner 6 striae moderately impressed, intervals subconvex, apical groove short and very rounded, joining third stria at level of anterior apical puncture. Aedeagus 0.62-0.77, mean 0.70 ± S.E. 0.04 mm long (N = 30), moderately and evenly arcuate, apex elongate, slender, and much produced; copulatory sclerite elongate.

Type series.—Holotype male (American Museum of Natural History) and 27 paratypes, Neil Fisher Cave (=Rip Van Winkle Cave), Smith Co., Tennessee, 25 March 1961, T. C. Barr; 33 paratypes, same cave, 18 October 1948, J. M. Valentine and W. B. Jones.

Measurements (in mm).—Holotype, total length 4.80, head 0.92 long

X 0.84 wide, pronotum 0.92 long X 1.06 wide, elytra 2.85 long X 1.79 wide, antenna 3.32 long.

Distribution.—One hundred seven specimens seen as follows. TENNESSEE: *Smith County.*—Neil Fisher Cave (type locality), New Salem Cave. *Putnam County.*—Bartlett, Bowen, Hargis, Jared Hollow, Petty, and Sadler caves. *Jackson County.*—Burial, Harris, Mahaney, Medley, and Carter caves (see Barr 1961 for cave locations).

Discussion.—This moderately large, robust, convex species is closely similar to *P. cumberlandus* but occurs on the opposite (south, left) side of Cumberland River. It is readily differentiated by characters given in the diagnosis. In the northern part of its range, *P. productus* is sympatric and syntopic with *P. simplex,* and at the southern margin of its range it is conjunct with *P. farrelli* Barr (*robustus* group), which occurs in nearby John Fisher Cave (Barr 1962). Superficially both *P. cumberlandus* and *P. productus* resemble species of the *robustus* group, but their distinctive aedeagi readily differentiate them as members of different groups.

Although a few other species of the *cumberlandus* group are rather robust, they are less convex and do not have the prominent humeri of *P. cumberlandus* and *P. productus.* Neither species is obligatorily riparian, although both are hygrophilous and somewhat seasonal in caves influenced by cold air flowing into large entrances. The niche filled appears to be much like that of *P. robustus* and its allies (other than *P. valentinei* Jeannel, which is riparian), and this ecological similarity may explain the conjunct, nonoverlapping ranges of *P. farrelli* and *P. productus.*

Pseudanophthalmus tiresias Barr, new status

Pseudanophthalmus tiresias tiresias Barr 1959:16. Type locality, Indian Grave Point Cave, Dekalb Co., TN.

This is a species found in mesic cave microhabitats, occurring on wet rotting wood and muddy floors rich in organic matter in the type locality cave and in nearby Fox Cave. It is sympatric with *P. farrelli,* which is conspicuously larger (see Barr 1962).

Pseudanophthalmus catherinae Barr, new status

Pseudanophthalmus tiresias catherinae Barr 1959:17. Type locality, Petty Cave, Marshall Co., TN.

Known only from the type locality along the banks of the cave stream, where it is moderately abundant. The species is rather robust but more depressed than *P. cumberlandus.*

Pseudanophthalmus insularis Barr, new status

Pseudanophthalmus tiresias insularis Barr 1959:18. Type locality, Baker Station Cave, Davidson Co., TN.

The type locality is a small stream cave in Silurian limestones of the Highland Rim margin north of Nashville; known only from the type locality, where it is rare. The species is small, slender, and depressed.

Pseudanophthalmus occidentalis Barr, new status

Pseudanophthalmus tiresias occidentalis Barr 1959:18. Type locality, DePriest Branch Cave, Lewis Co., TN.

Known only from the type locality cave and nearby Cave Branch Cave, Hickman County, Tennessee, this small, slender, depressed species is rare in both caves. It is potentially sympatric with *P. hesperus* Barr (*engelhardti* group), which occurs in the Blowing Caves, Perry County, Tennessee, but the two species have not yet been shown to coexist.

Pseudanophthalmus acherontis Barr, new status

Pseudanophthalmus tiresias acherontis Barr 1959:20. Type locality, Echo Cave, Rutherford Co., TN.

Known only from the type locality cave, apparently a branch of the extensive Snail Shell Cave system (in the main trunk of which it has not yet been collected), this small, slender, depressed species is found in riparian microhabitats. All available specimens are unusually pale, rufotestaceous.

Pseudanophthalmus tullahoma Barr, new status

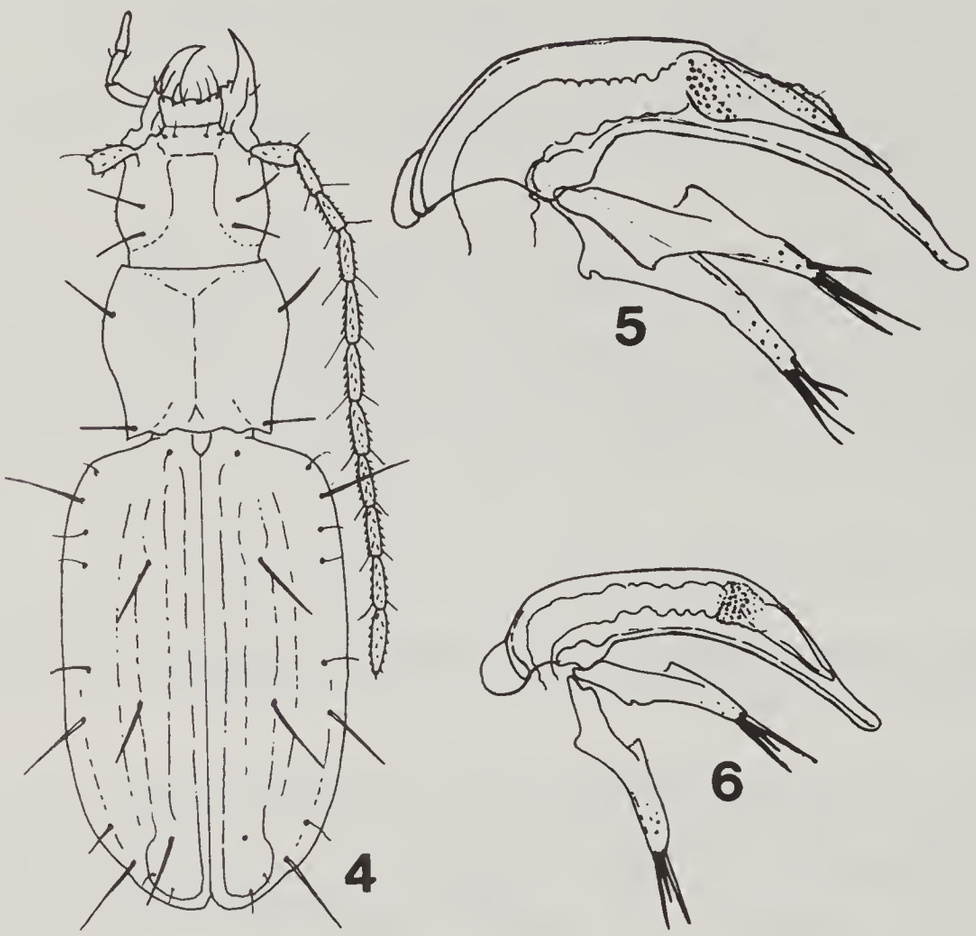
Pseudanophthalmus tiresias tullahoma Barr 1959:20. Type locality, Carroll Cave, Coffee Co., TN.

The species is known only from Carroll and Riley Creek caves, Coffee County, Tennessee, both of which have been flooded by the Tennessee Valley Authority's Normandy Dam on Duck River. In Carroll Cave this small, slender, depressed species occurred on rotting wood in a wet area, and in Riley Creek Cave it occurred in a muddy, periodically flooded area on rotting wood in which large numbers of *Onychiurus* collembolans were found.

Pseudanophthalmus bendermani Barr, new status

Pseudanophthalmus tiresias bendermani Barr 1959:21. Type locality, Benderman Cave, Maury Co., TN.

At the present time this species is known only from the type locality, an extensive stream cave containing much bat guano. The small, slender, depressed beetles are rather abundant in riparian microhabitats.



Figs. 4-6. *Pseudanophthalmus: cumberlandus* group. 4. *P. inquisitor,* n. sp. (3.4 mm). 5. Aedeagus, *P. productus,* n. sp. (0.75 mm). 6. Aedeagus, *P. inquisitor,* n. sp. (0.53 mm).

Pseudanophthalmus inquisitor, new species
Figs. 4, 6

Etymology.—Latin *inquisitor,* "searcher, inquirer."

Diagnosis.—A slender and depressed species characterized by very small size, non-pruinose elytral microsculpture, and the small, scarcely arcuate aedeagus with deflexed apex.

Description.—Length 3.1-3.9, mean 3.5 0.3 mm. Head rounded; labrum feebly trilobed; antenna 0.7 body length. Pronotum transverse, 0.87 as long as wide, margins arcuate in apical two-thirds, then oblique and scarcely sinuate at all to approximately right (or slightly acute or slightly obtuse) hind angles; widths at apex and base subequal and three-fourths greatest width, which occurs in apical third; base emarginate behind angles, secondary angles present; disc with rather long pubescence. Elytra elongate-oval, strongly depressed, 1.6 times longer than wide; microsculpture a fine, very tight, transverse meshwork; humeri angular, prehumeral borders almost perpendicular to midline; longitudinal striae 1-5 more or less complete and moderately impressed, intervals subconvex; apical groove short and widely rounded or (as in holotype) subparallel, joining third stria at anterior apical puncture. Aedeagus 0.48-0.52 mm long, basal bulb large but not sharply set off from median lobe, which is narrow and straight, its apex deflexed, produced, and bluntly rounded at tip; transfer apparatus a single, slender, elongate sclerite; parameres slender, with 3 apical setae.

Type series.—Holotype male (American Museum of Natural History) and one paratype, Sheals Cave, Clay Co., Tennessee, 7 April 1960, T. C. Barr. Three additional paratypes, same cave, 3 December 1960, T. C. Barr, and 5 paratypes, same cave, 11 August 1965, T. C. Barr and J. R. Holsinger. Known only from the type locality.

Measurements (in mm).—Holotype, total length 3.10, head 0.60 long X 0.62 wide, pronotum 0.65 long X 0.77 wide, elytra 1.85 long X 1.15 wide, antenna 2.18 long.

Distribution.—Sheals Cave is 0.8 km e of Celina, Tennessee, near the juncture of Obey and Cumberland rivers at the northeast margin of the Central Basin.

Discussion.—The species is sympatric and syntopic with *P. fowlerae* but is noticeably smaller. It is more readily collected in summer at the back of the entrance room, but a few specimens occur throughout the year along the stream in the back of the cave.

ACKNOWLEDGMENTS.—I thank Dr. John R. Holsinger for assistance in the field, and Drs. J. Manson Valentine and the late Walter B. Jones for contribution of specimens. The encouragement and cooperation of Mrs. Otia Fowler, owner of Sheals Cave at the time of my visits, is greatly appreciated.

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Breeding Migrations, Population Size Structure, and Reproduction of the Dwarf Salamander, *Eurycea quadridigitata,* in South Carolina

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ABSTRACT.—Life history parameters of *Eurycea quadridigitata* from two populations on the upper Coastal Plain of South Carolina were examined. Breeding migrations into Carolina bays occurred during September and October in 1978 and July through October in 1979. The initiation of breeding migrations was associated with a drop in air temperature during late summer or early autumn. The sex ratio of *E. quadridigitata* entering the breeding sites was 1:1. Egg deposition probably occurs during November and early December. Sexual dimorphism in snout-vent lenth (SVL) was not present, but there was significant local variation in SVL of adults ($\bar{x}$ = 26 and 29 mm). The number of ovarian eggs was positively correlated with SVL and varied between populations ($\bar{x}$ = 21 and 33).

INTRODUCTION

Although the dwarf salamander, *Eurycea quadridigitata,* is a widely distributed species in the southeastern United States (Dunn 1926; Mittleman 1947), life history information in most parts of its range is based on anecdotal observations (Bishop 1947; Dunn 1926; Neill 1949; Noble 1927). Sever (1975), in a more complete report, described seasonal variation of the nasolabial glands and included data on the male reproductive cycle. Harrison (1973) and Semlitsch (in press) provided ecological information on habitat, and reproductive and larval characteristics. Taxonomic accounts, distributional records, and other pertinent literature on the species were reviewed by Mittleman (1967).

As previously shown, the drift fence and pitfall trap technique provides an ideal sampling method for monitoring populations of fossorial amphibians (Gibbons and Bennett 1974; Gill 1978; Shoop 1965). Since lack of an adequate sampling technique has hindered the study of *E. quadridigitata,* this study was initiated to provide quanititative information on life history parameters of dwarf salamander populations from the upper Coastal Plain of South Carolina.

MATERIALS AND METHODS

Two Carolina bays, Rainbow Bay and Ellenton Bay, represent natural lentic habitats of the upper Coastal Plain (Schalles 1979) and were selected as study sites on the U. S. Department of Energy's Savannah River Plant (SRP) near Aiken, South Carolina. Rainbow Bay is a Carolina bay < 1 ha in area and is surrounded primarily by pine plantations. Slash pine, *Pinus elliotii,* and loblolly pine, *P. taeda,* surround the bay, with wax myrtle, *Myrica cerifera,* and blackberry, *Rubus* sp., providing the peripheral understory vegetation. Rainbow Bay is subjected to yearly drying, whereas Ellenton Bay is a more stable body of water, drying only twice in the last 24 years. Ellenton Bay is an approximately 10 ha Carolina bay surrounded by an old field community undergoing secondary succession (Gibbons 1970). Predominant plants peripheral to the bay are bush clover, *Lespedeza* sp., dog fennel, *Eupatorium* sp., and blackberry, *Rubus* sp.. Additional soil and vegetation characteristics are described in Odum (1960). Rainbow Bay is approximately 12 km (7.5 mi) from Ellenton Bay.

The drift fence and pitfall trap technique was employed at both bays. The Rainbow Bay drift fence was checked daily from 21 September 1978 through 30 December 1979. Individuals caught in pitfall traps were counted, and sex and reproductive condition noted before an animal was released on the opposite side of the fence. Samples for dissection were collected from pitfall traps at Rainbow Bay from 24 September through 30 November 1978 and at Ellenton Bay from 30 September through 10 November 1978. Movements of *E. quadridigitata* at Ellenton Bay were not monitored daily as they were at Rainbow Bay. Rainfall and minimum and maximum air temperatures at Rainbow Bay were recorded daily.

Salamanders kept for dissection were sacrificed in chloretone, preserved in 10% formaldehyde, and stored in 70% ethyl alcohol. Snout-vent length (SVL) was measured on preserved specimens from tip of the snout to posterior end of the cloaca. Individuals were dissected using a dissecting microscope to determine sex, reproductive condition, and ovarian egg size. The diameters of six eggs, chosen at random, were measured with a stage micrometer. Sexual maturity for males was determined by the amount of pigmentation on testes and size of the testes and vasa deferentia, and the presence of enlarged cirri (Gordon 1953; Sever 1975). Females were considered mature if eggs (> 0.7 mm) containing yolk were present in the oviducts or had recently been laid as evidenced by long, thin oviducts with clearly separated muscle bands (Gordon 1953; Ireland, 1976).

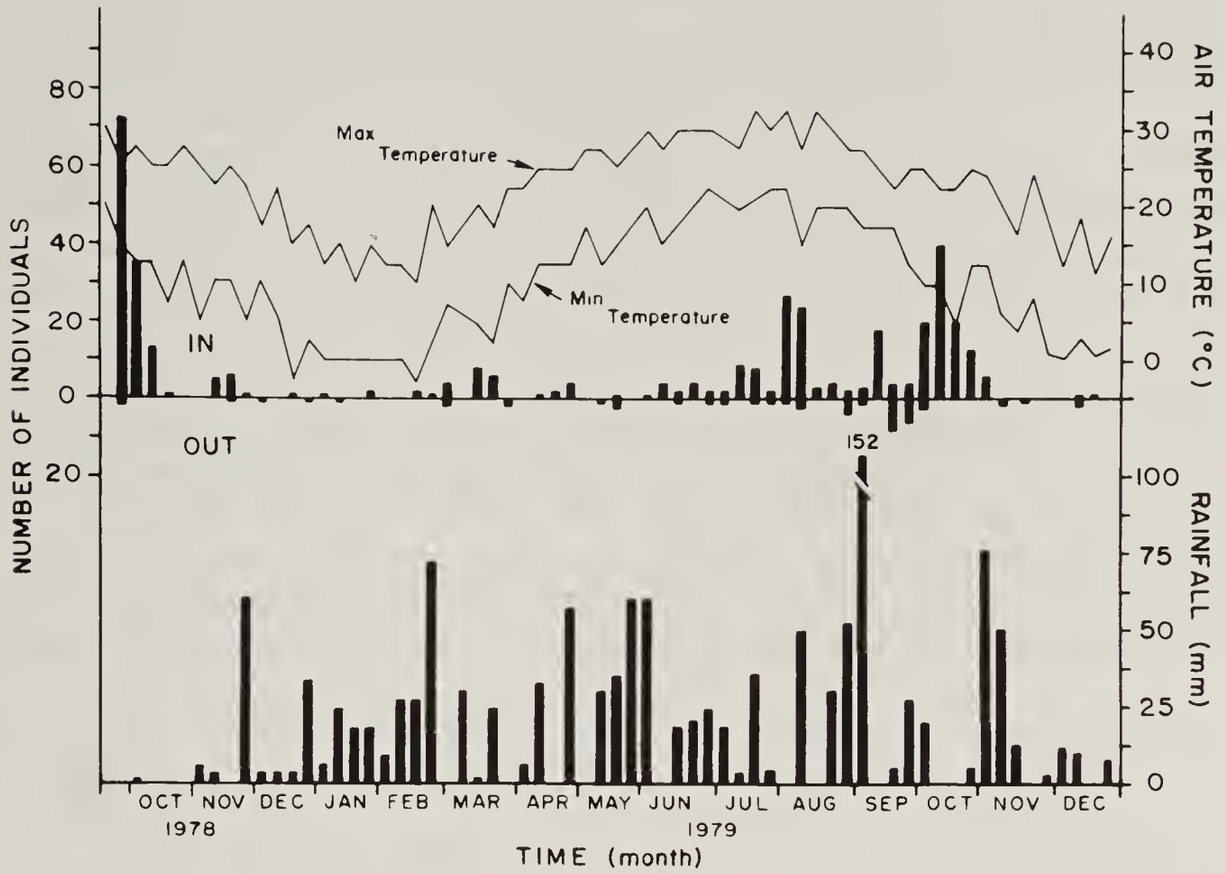

Fig. 1. Number of *Eurycea quadridigitata* captured during migration into and out of Rainbow Bay from 21 September 1978 through 30 December 1979. Number of individuals and rainfall plotted by weekly cumulative totals, air temperatures by weekly means.

RESULTS AND DISCUSSION

Breeding migrations.—The peak terrestrial activity period for adult *E. quadridigitata* appears to be late July through October (Fig. 1). During the 1978 season, animals caught between 21 September and 14 October at Rainbow Bay (N = 122), and on the night of 30 September, at Ellenton Bay (N = 40), represented mature adults entering the bays. Likewise, the majority of *E. quadridigitata* caught from 14 July through 30 October 1979 (N = 164) were adults entering Rainbow Bay in breeding condition (males with enlarged cirri; gravid females). Since these incoming salamanders were mature and in breeding condition we assume they were entering the bays to breed. Breeding migrations during 1979 appeared to be more diffuse than during 1978. This could be due to rainfall pattern, since the autumn of 1978 was very dry, whereas rainfall occurred frequently during the autumn of 1979 (Fig. 1). The amount and timing of rainfall has been shown to be an important proximate factor that may determine the onset and duration of these breeding migrations of other salamanders (Baldauf 1952; Shoop 1960, 1965; Gill 1978). There was no correlation between total number of captures per week and cumulative rainfall for the week or mean minimum and maximum air temperatures ($r = 0.16$, $p > 0.10$; $r = 0.09$, $p > 0.20$; $r = 0.14$, $p > 0.20$; respectively).

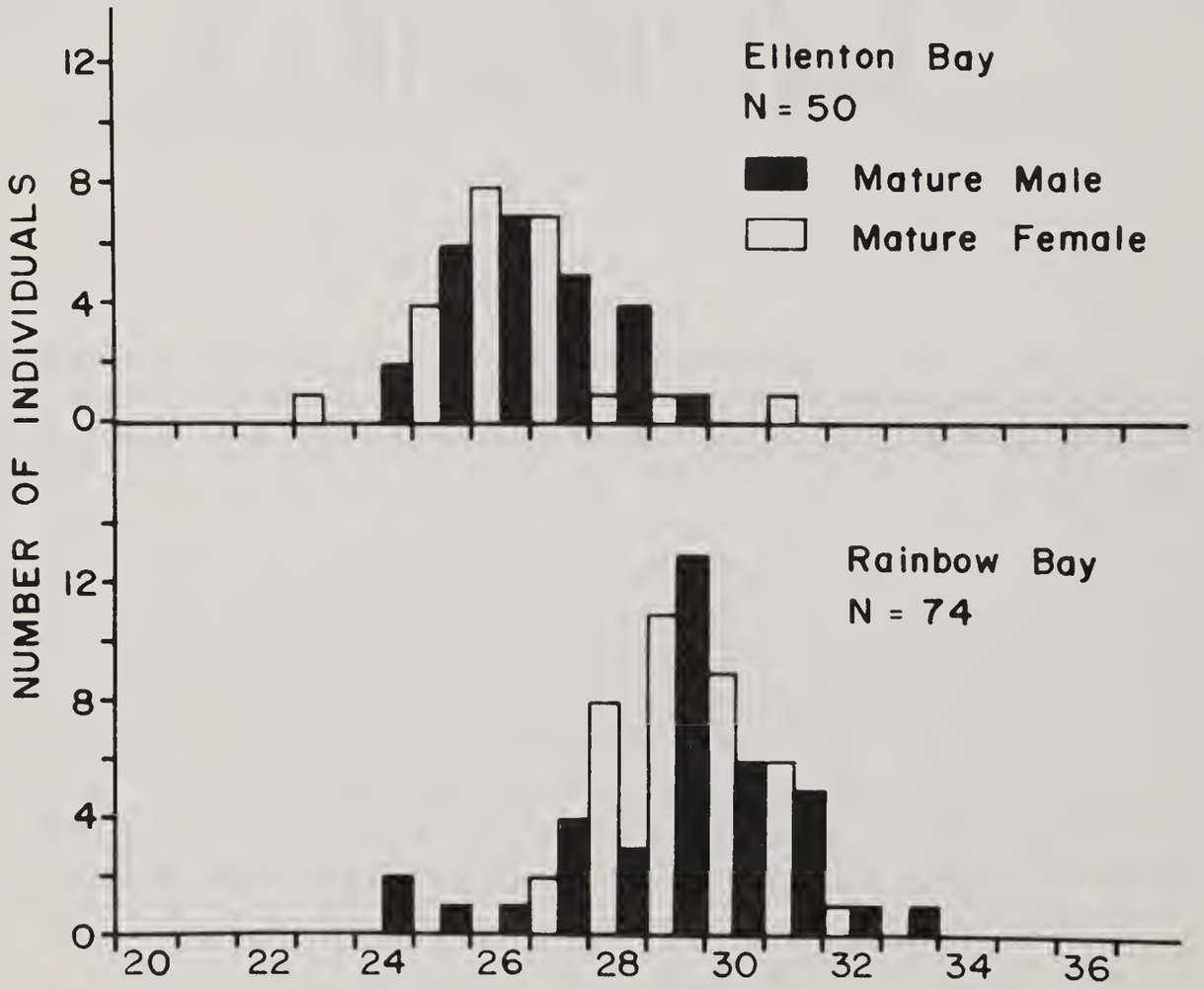

Fig. 2. Size-frequency distributions of breeding *Eurycea quadridigitata* entering Rainbow Bay and Ellenton Bay from 21 September through 30 November 1978.

However, it is clear from Fig. 1 that the initiation of breeding migrations is due to a drop in average air temperature over a several day period in late summer and early autumn. It should also be noted that breeding migrations of *E. quadridigitata* are probably adaptively adjusted for the autumn period since similar environmental conditions from January through June did not induce migration to breeding areas. Similar conditions were noted by Shoop (1960) for initiation of breeding migrations of *Ambystoma talpoideum* in Louisana.

The breeding migration period on the SRP corresponds with that reported by Harrison (1973) for the Charleston, South Carolina area, but the onset of movement to the bays on the SRP was about a month earlier. Variation in the onset of breeding migrations can be expected because of local and annual variation in climatic factors.

Data concerning the exiting of adults and/or metamorphosing juveniles during 1978 are not available since a large proportion of the breeding adult population was destructively sampled.

Population size structure.—Population size structure of *E. quadridigitata* entering Rainbow Bay and Ellenton Bay is shown in Fig. 2. All 124 individuals of both sexes entering the bays at this time were mature and their sex ratio did not differ from 1:1 ($\chi^2 = 0.48$, df = 1, $p > 0.40$, Rainbow Bay; $\chi^2 = 0.08$, df = 1, $p > 0.90$, Ellenton Bay). The mean SVL of adults was 29.1 ± 0.20 mm (N = 74, range 24-33 mm SVL) at Rainbow Bay and 26.4 ± 0.24 mm (N = 50, range 23-31 mm SVL) at Ellenton Bay. Local variation was evident in that adults from Rainbow Bay were significantly larger than those from Ellenton Bay (t = 8.77, df = 122, $p < 0.001$). Similar results were noted for metamorphosing *E. quadridigitata* juveniles from two populations (Semlitsch, in press) and may be explained by differential growth rates of juveniles in response to water temperature and/or food availability (Shoop 1974; Stewart 1956; Wilbur 1972; Wilder 1924). Since Rainbow Bay is smaller and more shallow than Ellenton Bay, the water may warm more quickly in the spring. Larvae from Rainbow Bay may grow more rapidly and gain a growth advantage that might be maintained to maturity.

Sexual dimorphism in body size was not present in *E. quadridigitata* since the SVL of males and females was not significantly different at Rainbow Bay and Ellenton Bay (t = 1.35, df = 72, $p > 0.20$; t = 0.29, df = 48, $p > 0.50$; respectively).

Size classes other than the unimodal distribution of adults were not found entering the bays during breeding migrations (Fig. 2). Year classes among adults cannot be distinguished on the basis of size. This could be because no growth occurs after sexual maturity is reached or because *E. quadridigitata* is short-lived and few adults survive to breed more than once during their life. The evidence presented supports the latter explanation, since very few adults ever leave the bays after breeding (Fig. 1, see 1979 season.)

Table 1. A summary of female body size and reproductive output of *Eurycea quadridigitata* from two populations in South Carolina. Values represent means ± 1 S.E. Measurements are in mm.

Parameter	Location	
	Rainbow Bay	Ellenton Bay
Smallest SVL of Gravid Females	27.1	22.9
SVL of Females	29.4 ± 0.23	26.7 ± 0.38
N	31	24
Mean Number of Ovarian Eggs	32.7 ± 1.36	21.4 ± 1.88
Range	18 - 48	7 - 42
N	31	24
Diameter of Ovarian Eggs		
September	0.93 ± 0.04	0.86 ± 0.06
N	13	18
October	1.09 ± 0.06	1.43 ± 0.08
N	11	4
November	1.48 ± 0.05	1.48 ± 0.20
N	7	2

Reproduction.—All female *E. quadridigitata* collected entering the bays during the period 21 September through 30 November 1978 that were dissected contained enlarged ovarian eggs. The smallest SVL of females with enlarged ovarian eggs was 27.1 mm at Rainbow Bay and 22.9 mm at Ellenton Bay (Table 1).

Gravid females are caught entering the bays in August through November. The diameter of ovarian eggs was similar between study sites and increased over time from 0.86 - 0.93 mm in September to 1.48 mm in November (Table 1). The largest egg diameter measured was 1.8 mm from a female caught on 15 November 1978 and is probably close to the size of eggs at deposition. Only two gravid females were caught after November. Therefore, time of egg deposition for the majority of dwarf salamanders is probably November or early December. Since egg deposition is synchronous and gravid females are not found at other times of the year, clutch frequency is no more than one per year. The number of ovarian eggs was positively correlated with SVL ($r = 0.67$, $p < 0.001$, for Rainbow Bay and Ellenton Bay combined; Fig. 3). The number of ovarian eggs was significantly greater at Rainbow Bay than at Ellenton Bay ($t = 5.10$, $df = 53$, $p < 0.001$; Table 1) and is attributable to the significant local variation in body size between populations.

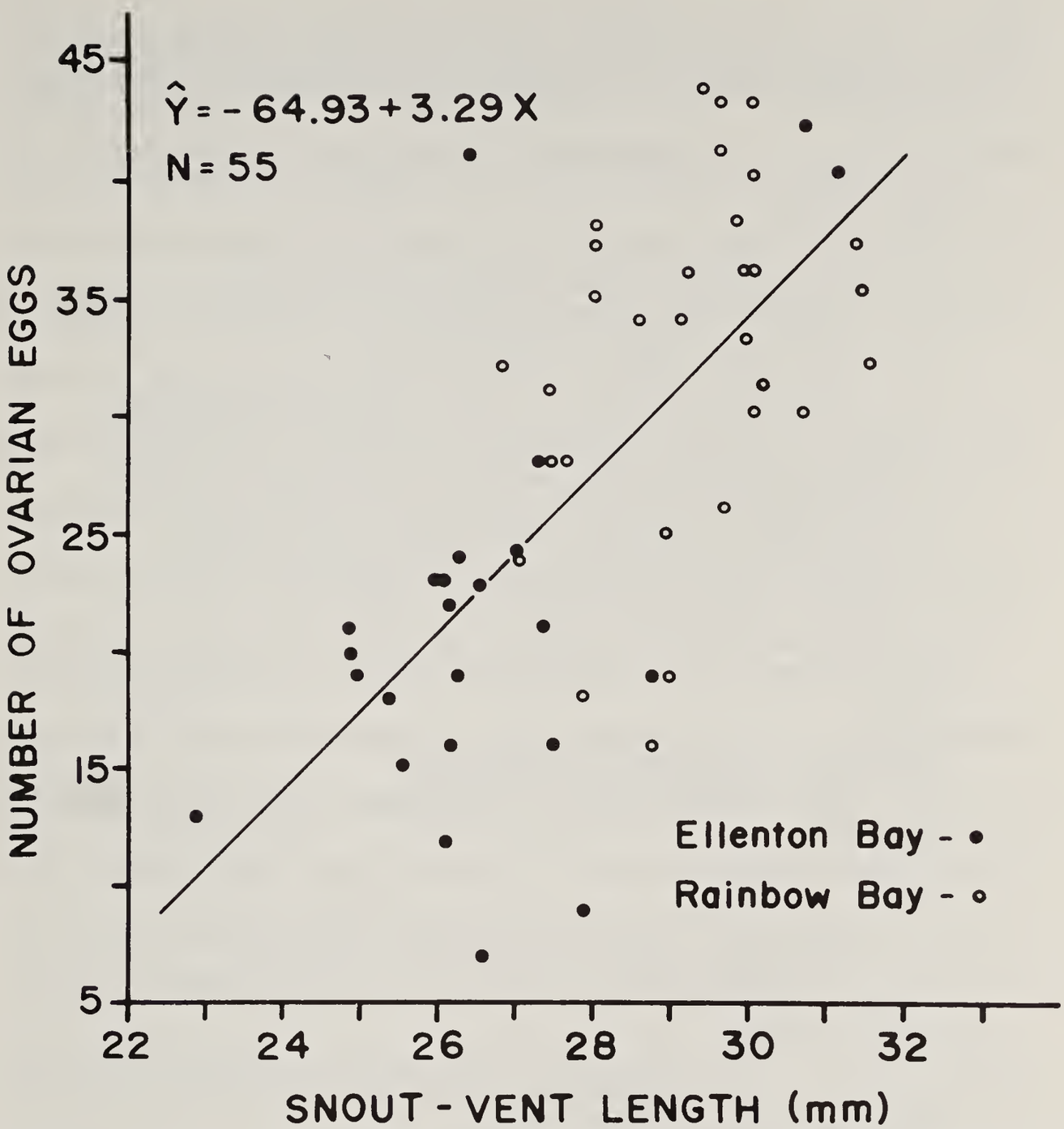

Fig 3. Relationship between number of ovarian eggs and snout-vent length of *Eurycea quadridigitata* from Rainbow Bay and Ellenton Bay. Data were pooled from both locations to calculate the regression equation.

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Occurrence of the "Tramp" Terrestrial Amphipods *Talitroides alluaudi* (Chevreux) and *T. topitotum* (Burt) (Amphipoda: Talitridae) in South Carolina[1]

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ABSTRACT.—Populations of the terrestrial amphipods *Talitroides alluaudi* (Chevreux) and *T. topitotum* (Burt) have been found in Charleston, South Carolina. Both species are of Indo-Pacific origin, but have been transported throughout the world through commerce. Typical characteristics found in fully terrestrial talitrid amphipods are seen in these populations.

INTRODUCTION

Practically all coastal biologists are familiar with supralittoral talitrid amphipods, common under algae, wrack and sand near the high tide mark. However, few are familiar with the biology of those talitrid species that have become fully terrestrial. These species show a distribution that is primarily tropical and Southern Hemisphere, with natural occurrences in the Northern Hemisphere largely limited to Japan and the Indo-Malayan region, including Hawaii (Hurley 1968). Bousfield (pers. comm.) is currently studying extensive material of endemic terrestrial amphipods from Jamaica and Hispaniola, and parts of Mexico and Central America. Hurley (1968) believed that their absence from North America and Eurasia was most likely due to restrictions imposed by continental climates. Their apparent absence from South America (except for a recent Brazilian introduction [Hurley 1975]) is, however, less easily explained.

Although a few species are found in grasslands (Hurley 1968), most live in forest humus. In some areas they are a major component of this cryptozoic fauna; Birch and Clark (1953) found 4000 m^{-2} in an Australian forest. High susceptibility to desiccation has restricted most species to moist habitats, which, together with an inability to survive heavy frost winters (Bousfield 1968), probably explains in large part why they have been less successful in invading terrestrial ecosystems than the more desiccation-resistant isopods (Hurley 1959).

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[1]Contribution Number 48 of the Grice Marine Biological Laboratory, College of Charleston.

In addition to natural talitrid dispersal by means of continental drift (Bousfield 1968, Hurley 1975), birds (Hurley 1959), and rafting, man has also played a part. Modern transplanting of exotic species of plants has resulted in the expanded distribution of many "tramp" (Bousfield and Howarth 1976) terrestrial species to other parts of the world. In these new locations they may be found in suitable habitats (where winters are mild) or greenhouses, where they have become a recognized component of a "hothouse fauna" including exotic species of insects, snails and isopods (Hurley 1959).

RESULTS

Populations of two species of terrestrial talitrid amphipods, *Talitroides alluaudi* (Chevreux) and *T. topitotum* (Burt), were found living in leaf litter and humus in Charleston, South Carolina. The population of *T. alluaudi* is located in a 2-4 m by 50 m strip of loose plant debris at the base of a northeast facing, residential stone wall. This habitat consists of leaf litter approximately 2 cm thick overlying dark, sandy loam, only the top 2-4 cm of which is humus rich. Leaves composing the leaf litter consist primarily of *Quercus laurifolia* (laurel oak), with additional leaves and plant debris from *Tilia caroliniana* (Carolina basswood), *Carya illinoensis* (pecan), *Prunus* sp. (cherry), *Ligustrum* sp. (privit), *Eriobotrya japonica* (loquat), and *Camellia japonica* (camellia). Common faunal groups found in this same habitat are pulmonate snails and slugs, isopods (*Armadillium* sp. and *Oniscus* sp.), collembolans, dermapterans, ants, cockroaches, millipeds and occasionally the terrestrial turbellarian, *Bipalium* sp.

I have collected specimens of *T. alluaudi* at this site since September, 1978. Their distribution within the habitat is clumped, with greatest densities occurring where the humus layer is thickest. A collection made in September, 1979, revealed an approximate density of 100 m^{-2} in such a humus rich area. Charleston specimens conform to Medcof's (1940) pleopod description, with all specimens examined having one third pleopod consisting solely of the protopodite and the other having a buttonlike, single outer ramal article. Males display the "mitten" second gnathopod morphology characteristic of female talitrids and males of most terrestrial species (Hurley 1959, 1968). Body lengths of Charleston specimens are approximately 5-7 mm, agreeing with lengths recorded by Shoemaker (1936) for those in California.

Approximately 6 km from the population of *T. alluaudi* is a population of *T. topitotum* living in leaf litter and humus around and under a house and adjacent shed. Amphipods were found in plant debris under the house, within a strip not exceeding 0.5 m from its edge and in an approximate area of 10 m^2 under and surrounding the small shed. Leaves composing the leaf litter consisted of *Carya illinoensis* (pecan), *Carya* sp. (hickory), *Liquidambar styraciflua* (sweetgum) and *Magnolia grandiflora*

(southern magnolia). Faunal groups other than amphipods found in this plant debris were the same as those listed above for *T. alluaudi.* I collected specimens of *T. topitotum* at this site from August, 1974, to June, 1977, at which time a large population was present.

A second population of *T. topitotum* was found in March, 1980, living in a relatively undisturbed forest located across from Harborview Shopping Center, approximately 3.5 km from the population described above. The approximately 20 ha mesic forest, which surrounds a lake, has a canopy (and leaf litter) consisting primarily of *Quercus falcata* (southern red oak), *Pinus taeda* (loblolly pine), and *Quercus laurifolia* (laurel oak). *Talitroides topitotum* is found in small numbers (< 1-50m^{-2}) in the thick humus layer in various parts of the forest. Higher densities (90-140 m^{-2}) are present within 10 m of the edge of a small swamp adjacent to the lake. Where the soil is saturated with water, however, *T. topitotum* is absent. Pleopods of Charleston specimens of *T. topitotum* conform to Burt's (1934) description. Published body lengths of 5-13 mm (Shoemaker 1936) are not very different from the maximum recorded length in Charleston specimens of 10 mm.

Voucher specimens of both *Talitroides* species have been deposited in the collections of the Canadian National Museum of Natural Sciences, Ottawa; the Grice Marine Biological Laboratory, Charleston; the North Carolina State Museum of Natural History, Raleigh (10 *T. topitotum,* NCSM C-323; 10 *T. alluaudi,* NCSM C-324); and my personal collection.

DISCUSSION

Both *T. alluaudi* and *T. topitotum* are of Indo-Pacific origin and undoubtedly were transported to Charleston with exotic species of plants common in this coastal, subtropical city. They are two of only three species of terrestrial amphipods recorded from the continental United States, the third being *Arcitalitrus sylvaticus* (Haswell), found in California (Bousfield and Carlton 1967).

Talitroides alluaudi was first described by Chevreux (1901) from the Seychelles Islands in the Indian Ocean, where it lives in rotten trunks of coconut trees and forest humus (Shoemaker 1936). Figures of this species are in Chevreux (1901) and Reid (1947). *Talitroides alluaudi,* discovered in an Ohio greenhouse (Visscher and Heimlich 1930), was the first fully terrestrial amphipod found in the continental United States. Wild populations have been found on various Indian Ocean and Polynesian islands, the Canary Islands, the Azores (Hurley 1975), Hawaii (Bousfield and Howarth 1976), California (Bousfield 1975), Florida and Georgia (Bousfield unpublished). Greenhouse populations have been found in Ohio (Visscher and Heimlich 1930), New Jersey (Shoemaker 1936), Illinois, Ontario (Medcof 1939), and at least eleven European countries (Hurley 1959).

Talitroides topitotum was first described by Burt (1934) from

specimens found under a crate in a garage 80 km from the coast at 1311 m in Ceylon (Sri Lanka). Good figures of this species are in Burt (1934) and Shoemaker (1936, as *Talitrus sylvaticus* Haswell). The first published occurrence of *T. topitotum* in the United States was that by Shoemaker (1936, as *Talitrus sylvaticus)* in California gardens, where it on occasion reached pest densities. If *T. topitotum, T. pacificus* Hurley and *T. decoratus* (Carl) are synonymous (Hurley 1975), *T. topitotum* has wild populations in India, Australia, many Indo-Pacific islands, Brazil, the Azores, Madeira (Hurley 1975) and, in the United States, California (Shoemaker 1936), Florida, the Gulf Coast (Bousfield, unpubl.) and Hawaii, where it has become the dominant amphipod species in leaf litter (Bousfield and Howarth 1976).

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Some Historical Data Bearing on the Pine Barrens Treefrog, *Hyla andersoni,* in South Carolina

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ABSTRACT.—Hyla andersoni, the Pine Barrens Treefrog, was described in 1854 by Baird from a specimen sent apparently by Charlotte Paine of Anderson, South Carolina, a site some distance inland from the sandhills strip. The type locality has long been in question. The species has since been collected in South Carolina, but apparently not yet at a point close to Anderson. Charlotte Paine and/or her co-worker, Mrs. M. E. Daniel, were located in Anderson from 1848 through 1857 and sent Baird many specimens, including the single *H. andersoni.* Attempts to trace travels and routes of these women, activities of potential student collectors at the Anderson school where they taught, and other historical aspects, have shed no further positive light on the source of the type specimen.

Baird (1854) described *Hyla andersoni* from a single specimen sent to him from Anderson (Anderson County), South Carolina, apparently by a local teacher, Charlotte Paine. A perennial question has concerned the actual point of collection of the Anderson frog, thus the type locality of the species, especially in the absence of other South Carolina specimens (Gosner and Black 1967, Neill 1947, Wright 1932). Whereas *H. andersoni* is usually considered to be restricted to pockets in the pine barrens region, the town of Anderson is located well up in the Piedmont Plateau, some 70 airline miles inland from the Fall Line and perhaps 65 miles from the nearest margin of the sandhills strip. (Reduce either of these distances by about 15 miles to reach only the lower border of Anderson County.) Furthermore, some early collectors paid little attention to exact locality records and individual specimens often were not labeled. Any specimens sent in by Charlotte Paine and her co-worker, Mrs. M. E. Daniel, probably were recorded at the destination as simply "from Anderson."

Although it is well known that certain typical Coastal Plain forms extend sparsely into the Piedmont here and there, especially farther south, this topic has not been adequately investigated. Folkerts (1971) reported *Ambystoma tigrinum* and *Eurycea quadridigitata* from Anderson County and the latter also from Pickens County. I have seen this *Eurycea* north of Greenville in Greenville County, and *Scaphiopus holbrooki* just south of Belton in Anderson County, and I believe Franklin Sherman had records of *Cemophora coccinea* in Pickens County. Although I did not see a specimen, I was told locally of an apparently reliable record of *Farancia abacura* from about nine miles down the Savannah River from a point opposite Anderson. While these remarks refer to typical Coastal

Plain forms, many workers would not consider *Hyla andersoni* to be a "typical" such form.

The Fall Line, incidentally, is a convenient boundary but not necessarily a barrier. The 500-foot contour runs roughly along the Fall Line and, of course, turns inland up each river valley. Although the fact may not be significant, it is worth noting that this contour extends up the Savannah River to lower Anderson County and up the Saluda River to Ware Shoals, upper Greenwood County.

I first gained some familiarity with *Hyla andersoni* at various points in the North Carolina sandhills during the late 1940s. The frog virtually had to be present in South Carolina. Hence, in 1950 I started looking for it there, and found it in mid-June just south of Patrick, Chesterfield County (EEB 2200-01). In early July of that year it was found in Kershaw County at a site that I again checked in 1951 (EEB 3124-5), 1952, 1965 (EEB 6529-30) and, less carefully, several times since. As the populations appeared to be small and there was no evident protection in sight for the species, it simply did not seem wise to advertise these locality records. My few South Carolina specimens of *H. andersoni* will be placed in the Charleston Museum and the U. S. National Museum. Any worker requiring the location of the Kershaw County collecting site should contact the Charleston Museum, Julian R. Harrison at The College of Charleston, or the South Carolina Wildlife and Marine Resources Department (Nongame and Endangered Species Section), Columbia.

My limited forays did not yield the frog farther southwest along the sandhills strip, including the Aiken County portion of the area now controlled by the Savannah River Plant of the Atomic Energy Commission. Once, after a heavy night rain, I thought I heard it in Lexington County near US 1 on the Cayce side of the rivers opposite Columbia, but I could not verify this. Nor did I find the frog in, or toward, the Anderson area.

In recent years, other workers have begun to encounter *H. andersoni* in South Carolina. With interested observers now nearer to the scene, it may eventually be possible to guess where the type specimen might have originated. Neill (1947) perhaps wisely suggested that the type locality of *H. andersoni* be considered unknown. Schmidt (1953) without comment designated it as the present Aiken County.

Hoping that a different approach might yield helpful clues to answer the question of the type locality, I have devoted much time and effort to learning what I could concerning Charlotte Paine and the school at Anderson. I have not solved the problem of the source of the type specimen. The following gleanings comprise history rather than herpetology, but to prevent repetition of effort by other persons they should be on record.

Some writers (Wright and Wright 1949, Neill 1947) seem to have mistakenly assumed that Charlotte Paine and Mrs. M. E. Daniel were one and the same person. Neill (1954:90) appeared to suggest that a Col. M. E. Daniels of Augusta may have been the husband of our Mrs.

Daniel, and that most of the Paine-Daniel specimens might have come from the Augusta area. I have not been able to identify Neill's Col. Daniels, but details following will suggest that he could not have been associated with the Mrs. Daniel in question.

Phoebe and Charlotte Paine, originally from the area of Portland, Maine (their father practiced medicine at Limerick, Windham and Portland), but later long time residents of Carlisle, Pennsylvania, came to Spartanburg, South Carolina, about 1839 to teach (Paine 1883, Landrum 1900, Vandiver 1928). With these sisters came their niece, Mary Eliza Webb, who later married Dr. Robert M. Daniel of Spartanburg but became a widow within a few months. As Mrs. Mary E. (Webb) Daniel she, along with Charlotte Paine, in 1848 accepted a supervisory and teaching position in the newly organized Johnson Female Seminary at Anderson, South Carolina. Paine was present at Anderson from 1848 through the session beginning in 1852, thereafter apparently returning to Carlisle. Except for the 1852 session, Daniel was present from 1848 until her death in 1857 (a year when the school was ravaged by disease).

While in Carlisle, both women were well acquainted with Spencer F. Baird and his wife. They obviously had promised to send Baird specimens if he would send them books. Limited correspondence between them is preserved in the Smithsonian Institution archives, although several items have faded to illegibility. Charlotte Paine sent a container of specimens from Anderson to Baird at Carlisle in 1848, and another in 1849. Baird complained that the 1849 collection arrived with specimens in a very poor state of preservation (a common difficulty, as shipment required months and the preservative often evaporated, or was drunk, prior to arrival at the destination). Baird moved to the Smithsonian Institution in 1850 and Mrs. Daniel sent another container of specimens in 1853. According to G. R. Zug and W. A. Deiss (pers. comm.) of the Smithsonian, no specimens were received during the 1850-52 period.

The letters of Paine and Daniel infrequently refer to frogs and do not indicate that the women were aware of the specimen of *H. andersoni* when it passed through their hands. Allowing for some possible paraphrasing on my part in taking notes, C. Paine noted in a letter to Baird in July, 1848, that she "had sent a can of common specimens of reptiles, including one horn snake [presumably *Farancia*], furnished by a gentleman from his plantation. The little girls and boys brought in the lizards, small frogs and common snakes . . . A servant brought in a basket of live frogs caught with hook and line." In November, 1848 she wrote, "I took a great fancy to those bright little green frogs, with their rolling eyes and quick movements . . .," and in May 1849, "Some gentlemen in Abbeville district have promised specimens of joint snake and horn snake, when they can be met with. These are rare and seldom found. Most Northerners disbelieve the existence of these two. Therefore I wish to send convincing proof of there being such reptiles. And the deadly power of the horn snake no one can doubt."

Writing to Mrs. Daniel in April 1853 Baird clearly referred to the specimen of *H. andersoni*: "I send today a copy of our serpent book which I trust you will look over with interest. You will see by the frequent reference to Anderson how valuable your contributions have been.

"We are now at work on the frogs and other Batrachians and already have some things from Anderson. In particular there is one tree frog, the only one I ever saw, entirely new, but which, unfortunately, was so much rubbed as to be defaced. It appears to have been slender, and quite smooth above; perhaps green or olive, with a great number of small round yellowish spots on the legs. Please catch, and have caught, all the tree frogs in the country, so as to secure more of this."

In October 1853 Baird again inquired about the frog. Mrs. Daniel's letters to Baird in 1853-54 do not indicate that she remembered the specific frog in question. To my knowledge, neither Paine nor Daniel left any helpful diary or catalogue of collections.

The situation of Paine and Daniel at Anderson was a confining one, with virtually no opportunity for travel. In journeying from Pennsylvania to Anderson they came to Charleston by sea. The 135 mile railroad, said to have been the longest in the world when completed in 1833, came in from Charleston to Hamburg (just across the Savannah River from Augusta) (Phillips 1908). Its branch to Columbia was finished in 1842. The extension from there to Anderson was not completed until 1853, hence is not significant here. I am not certain about the late 1840s, but in the early days of the trip to Hamburg a traveller came in 90 miles to Blackville, then stopped for the night. At the edge of Blackville the railroad crossed an interesting "Carolina bay". Its frog fauna includes *Rana grylio,* but I did not find *Hyla andersoni* there.

Charlotte Paine stated that travel from the Augusta area to Anderson was by wagon, or possibly by stage if a person were travelling light. She did not mention the route of travel, but rather hazy maps in Colton (1856) and Simms (1843) suggest that at least three were possible: 1) to Edgefield, then Abbeville and Anderson; 2) a route nearer the Savannah River, toward Calhoun's Mill (apparently on Little River at the upper edge of present McCormick County) and then to Abbeville and Anderson; 3) up the west side of the Savannah, crossing at then existent Petersburg or Vienna (just above the confluence with Broad River), thence to Calhoun's Mill, Abbeville and Anderson.

Mrs. Daniel occasionally visited friends or in-laws in Union district, apparently at or near Pacolet Mills in the edge of present Spartanburg County. However, this would have been only during December or January.

The school at Anderson operated on two five-month terms, one from early February through June, and the other from early July through November. Commencement came in late July, followed by one week of "recreation". December and January were the chief vacation period.

To speculate concerning the origin of the specimen of *Hyla andersoni,* it might have been brought in by: 1) a more or less local student or other person; 2) a student coming from a more distant home at the beginning of a term; 3) a travelling acquaintance passing through Anderson; or 4) a parent or alumna returning to the school at commencement time or at the end of a term. My present guess is that the frog was collected some distance from Anderson and brought over many miles of rough roads stuffed in a small container of "spirit". It was then simply dropped into the keg of specimens being accumulated by Paine and Daniel. Had this particular frog been brought in alive, it seems logical that these women would have remembered it.

The Anderson school's records were burned during a military raid in 1865. However, copies of some of the pertinent circulars or catalogs are in the Furman University Special Collections or in the University of South Carolina's South Caroliniana Library at Columbia.

I have examined the lists of students for appropriate years, especially 1848 and early 1849, in an attempt to guess who might have obtained the frog in question. Most of the students (63% to 72%) were from Anderson district, several from Abbeville district. Mary and Elizabeth Morris, Julia Horsey, and Cassandra Hewitt made the trip in from Charleston. Mary S. Coleman and Harriet Hibler were from Edgefield district. Elizabeth and Eugenia Higgins lived on the hill above the Saluda River (Newberry side) where the Saluda-Newberry highway (SC 121) now crosses. Their father ran the ferry there. Augusta G. Thompson and Jerusha Prince were respectively from Chickasaw and Tippah counties, Mississippi. Is there any chance of the frog's being present in that northeastern portion of that state? In our present state of ignorance, all of the above individuals would have to be considered possibilities. There was no student from Columbia (or north of there) until Fannie Caldwell in 1851.

Any good South Carolina map of the time (I had Mitchell's 1850 one) should show that Anderson district corresponded to present Anderson County, but Abbeville district included present Abbeville and much of Greenwood and McCormick counties. Edgefield district included present Edgefield and Saluda, plus small portions of Greenwood, McCormick and Aiken counties. There was no Aiken County in 1850.

One possibility is so remote that even to bring it up is questionable: Could the specimen of *H. andersoni* have been collected by Dr. John P. Barratt and become mixed with the Paine-Daniel specimens at the Smithsonian? Barratt's specimens were sent to Washington from Abbeville district. He lived a few miles south of the present town of Greenwood. According to information provided by E. D. Herd, Jr., about 1845 Barratt travelled slowly through parts of the sandhills strip and deeper into the lower Coastal Plain with M. Tuomey, state geologist. The trip was primarily a geologic one, but a person of Barratt's biological interests would have been ever alert for unusual specimens.

ACKNOWLEDGMENTS.—I am indebted to the following: the late A. L. Pickens and Doris Cochran for early suggestions; Daughters of the American Revolution Library (Washington); Smithsonian archives (Anita Lonnes); Cumberland County (Pennsylvania) Historical Society and Hamilton Library Association (Kathryn F. Brougher); Cumberland County (Pennsylvania) Records Office; Maine Historical Society (Elizabeth Ring); Furman University Library and Special Collections (especially R. S. Lillard); University of South Carolina South Caroliniana Library; E. Don Herd, Jr., for generously allowing me to examine his unpublished study of the John P. Barratt papers; South Carolina State Archives; Anderson County Records Office; Spartanburg County Records Office; Spartanburg *Herald Journal* for use of microfilm. This work was supported in small part by Davidson College Faculty Research funds.

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Ambystoma mabeei Bishop (Caudata: Ambystomatidae): An Addition to the Salamander Fauna of Virginia

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ABSTRACT.—Ambystoma mabeei from Southampton County and Suffolk, Virginia extend the known range of the species 46 km (28.6 mi.) northward from North Carolina. Juveniles of this uncommon species are described for the first time. An updated distribution map is included.

Species with restricted ranges are of special interest to the biogeographer and ecologist. Their distributions, if accurately defined, may provide clues to their environmental tolerance limits. One such species is the salamander *Ambystoma mabeei,* known only from the Coastal Plain of North Carolina and South Carolina (Hardy and Anderson 1970). This note reports specimens from two additional localities that significantly extend the known range of this species northward. All specimens are in the collection of the National Museum of Natural History (USNM).

On 29 April 1979 an adult female *A. mabeei* (USNM 212212) and two recently metamorphosed juveniles (USNM 212213-14) were collected by Joseph C. Mitchell and Wendy H. Mitchell 7 km (4.3 mi.) northwest of Courtland, Southampton County, Virginia. On 17 May 1979 three other recently metamorphosed juveniles (USNM 212215-17) were collected at the same locality. On 16 June 1979 S. Blair Hedges found a juvenile (USNM 211210) 5 km (3.1 mi.) south of Suffolk, City of Suffolk (formerly Nansemond County), Virginia. These specimens represent the northernmost localities known and the first records of the species for Virginia. The previous northernmost site is 46 km (28.6 mi.) to the south in Perquimans County, North Carolina (Palmer et al. 1974). Figure 1 shows the updated range and all known localities of *A. mabeei.*

The adult female from Southampton County, Virginia has the following characteristics: snout-vent length (SVL; to posterior margin of vent) 54.3 mm; total length (TL) 93.1 mm; costal grooves 13R/13L. The dorsum in life was black with scattered white flecks (most concentrated

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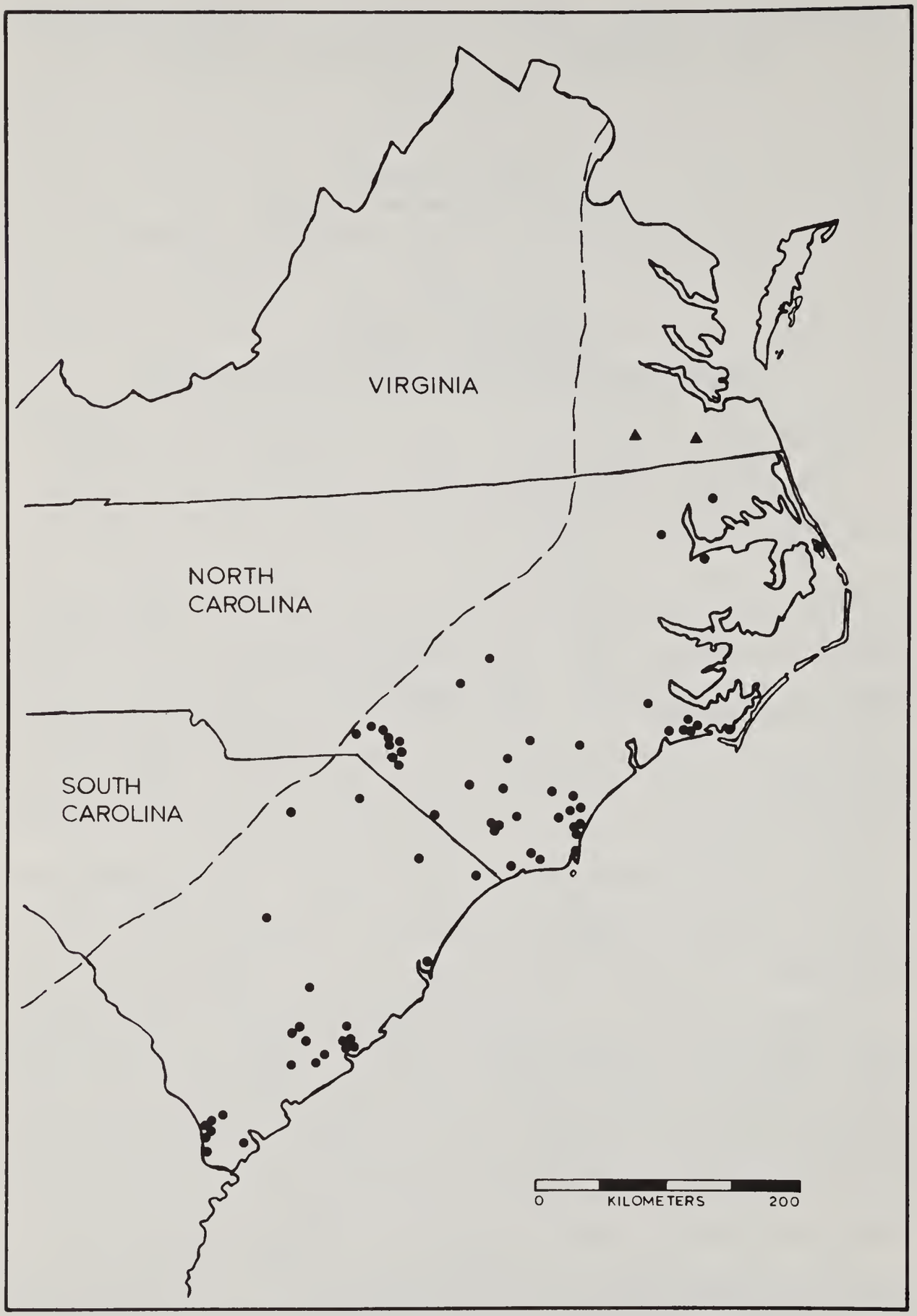

Fig. 1. Locality records for *Ambystoma mabeei*. Triangles indicate new localities herein reported; circles indicate literature and museum records. The dashed line represents the Fall Line.

laterally), and brown after preservation. The venter was slate gray with some white flecking on the chin. All juveniles from this locality possess gill buds, indicating recent transformation from the larval stage. The five specimens in the series measured (mm):SVL=36.7-46.0 ($\bar{x}$=42.0); TL=60.1-78.6 ($\bar{x}$=70.4). These individuals were uniform black dorsally with a single lateral row of flecking. Their ventral surfaces were uniform slate gray and their ventrolateral margins were marked with a row of white spots. The Suffolk specimen is an older juvenile (SVL=39.5 mm, TL=63.9 mm) with no gill buds; costal grooves 13/13; concentrated lateral flecking; and brown dorsum in preservative.

The Suffolk specimen was found under a pine log on the side of a sawdust pile. Here the surrounding vegetation consists mainly of Red Maple, *Acer rubrum,* with some Loblolly pine, *Pinus taeda,* and oaks, *Quercus* spp. The Southampton County locality is a cutover and burned pinewoods flatland with secondary growths of cane, *Arundinaria* spp., seedling Sweetgum, *Liquidambar styraciflua,* and Red Maple. Throughout this area are ditches and pools that contain varying amounts of water. All *Ambystoma mabeei* found at this locality were taken during the day under pieces of paper or small logs in sandy areas adjacent to water. Both localities are similar to *A. mabeei* habitats described by Hardy (1969).

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ERRATA

The following errors appeared in *Brimleyana* No. 2:

Page 31, lines 18 and 19 — *T. toxawayi, T. howellae,* and *T. coweensis* should appear as subspecies of *T. aduncus* instead of full species.

Page 33, alternative 12 of the key, last line of second option — change 15 to 14.

Page 94. The magnifications for Fig. 3 were in error; the caption should read — Photomicrographs of copulatory organs in sagittal section. A, *Phagocata carolinensis*, X42; B, *Phagocata holleri,* X90.

Page 133. Fig. 2 was incorrectly cropped and the meter rule omitted.

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